(NAVY) NAVAIR 01-1A-20
(AIR FORCE) T.O. 42E1-1-1
30 July 2007

TECHNICAL MANUAL

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

AVIATION HOSE AND TUBE MANUAL

N68936-04-D-0008

This publication supersedes NAVAIR 01-1A-20 dated 1 June 2002.

This publication supersedes Air Force T.O. 42E1-1-1 dated 1 January 2007.

This publication incorporates Chapter 13 of Air Force T.O. 1-1A-8 dated 15 May 2007.

Published by Direction of the Commander, Naval Air Systems Command

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NUMERICAL INDEX OF EFFECTIVE WORK PACKAGES/PAGES

List of Current Changes

Original 0 ..... 30 July 2007, including IRACs/RACs 1 through 4

Only those work packages/pages assigned to the manual are listed in this index. Insert Change _, dated _____. Dispose of superseded work packages/pages. Superseded classified work packages/pages shall be destroyed in accordance with applicable security regulations. If changed pages are issued to a work package, insert the changed pages in the applicable work package. The portion of text affected in a change or revision is indicated by change bars or the change symbol “R” in the outer margin of each column of text. Changes to illustrations are indicated by pointing hands, change bars, or MAJOR CHANGE symbols. Changes to diagrams may be indicated by shaded borders.

Total number of pages in this manual is 436, consisting of the following:

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HMWS-1	Warnings Applicable to Hazardous Materials	009 01	Cleaning, Oxygen Systems Tubing, Fabrication, AIR FORCE USE ONLY
001 00	Alphabetical Index	010 00	Tube Assemblies, Maintenance
001 01	Cross-Reference and Procurement	010 01	Tube Assemblies, Maintenance, AIR FORCE USE ONLY
002 00	Introduction	011 00	Permaswage Fittings, Description and Maintenance
003 00	Hoses, Hose Assemblies and Hose Fittings, Description	012 00	Rosan Fittings, Description and Maintenance
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004 05	High Pressure Rubber Hose Assemblies, Fabrication	018 00	High Volume Air Delivery Duct Assemblies, Description and Maintenance, AIR FORCE USE ONLY
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NUMERICAL INDEX OF EFFECTIVE WORK PACKAGES/PAGES

WP/Page Number	Change No.
Title	0
A – B	0
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TPDR-1	0
TPDR-2 Blank	0
HMWS-1 – HMWS-7	0
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R 101100Z JUL 13 IRAC 009 TO 01-1A-20 AND TO 42E1-1-1 DTD 30-JUL-2007// COMNAVAIRSYSCOM PATUXENT RIVER MD

TO AIG 423
FLTREADCEN EAST CHERRY POINT NC//V-22FST//

INFO COMNAVAIRSYSCOM PATUXENT RIVER MD//DRPO//
COMNAVAIRWARCENACDIV PATUXENT RIVER MD
FLTREADCEN EAST CHERRY POINT NC//V-22FST//

UNCLAS//N05600//
MSGID/GENADMIN/MIL-STD-6040(SERIES)/B.0.01.00
/COMNAVAIRSYSCOM PAX DRPO/-/-/-/-/USA/UNCLASSIFIED// SUBJ/IRAC 009 TO 01-1A-20 AND TO 42E1-1-1 DTD 30-JUL-2007// REF/A/DOC/COMNAVAIRFORINST 4790.2B/15MAY2012// REF/B/PUB/NAVAIR 00-25-100/30DEC2011// REF/C/DOC/N65923-13-0342/19FEB2013// NARR/REF A IS THE NAVAL AVIATION MAINTENANCE PROGRAM REF B IS THE NAVAL AIR SYSTEMS COMMAND TECHNICAL MANUAL PROGRAM REF C IS THE TECHNICAL PUBLICATION DEFICIENCY REPORT// POC/CRUSE, MARIA/-/FLTREADCEN SOUTHWEST SAN/LOC:6.8.5.1 //TEL:619-545-3646// GENTEXT/REMARKS/THIS MESSAGE WAS AUTO GENERATED FROM THE JDRS WEBSITE FOR NON-WEB SITE CAPABLE ORGANIZATIONS. THE REPORT WAS ORIGINATED BY:
------ FLTREADCEN EAST CHERRY POINT NC/V-22FST.
IF RESPONSE VIA WEB SITE IS NOT POSSIBLE, TO: LINE RECIPIENTS SHOULD ADDRESS RESPONSE DIRECTLY TO:
------ FLTREADCEN EAST CHERRY POINT NC/V-22FST WHEN APPROPRIATE. THIS DEFICIENCY REPORT WILL BE PROCESSED VIA THE JDRS WEBSITE. FOR FURTHER DETAILS OR REAL TIME STATUS VISIT THE JDRS WEB SITE AT: JDRS.MIL.
1. IRAC 009 TO 01-1A-20 AND TO 42E1-1-1 DTD 30-JUL-2007
2. PURPOSE OF CHANGE: TO INCLUDE THE REQUIREMENT FOR THE INTERMEDIATE LEVEL TO MARK HOSES.
3. DETAILED INFORMATION: PEN AND INK CHANGES TO THE TECHNICAL CONTENT OF A MANUAL ARE NOT AUTHORIZED. THE FOLLOWING TECHNICAL CONTENT CHANGE INFORMATION APPLIES TO THE FOLLOWING REFERENCED PAGES AND PARAGRAPHS OF THE SUBJECT MANUAL UNTIL THE FORMAL CHANGE IS RELEASED.
IN WP 004 00, PARA 10, PAGE 3, THE FIRST SENTENCE SHALL BE CHANGED AS FOLLOWS: "HOSE ASSEMBLIES MANUFACTURED BY DEPOT AND INTERMEDIATE MAINTENANCE LEVEL ACTIVITIES SHALL HAVE A METAL TAG."
4. VALIDATED BY: MICHAEL GRAVES, FRC EAST, 4.3, 252-464-6180, 464-6180, MICHAEL.D.GRAVES2@NAVY.MIL
5. RELATED INSTRUCTIONS:
A. FOR IRACS AFFECTING MANUALS IN PAPER COPY - MAINTAIN THIS IRAC WITH THE APPLICABLE MANUAL BY PLACING OR ATTACHING IT DIRECTLY BEHIND THE TITLE PAGE. MARK THE SPECIFIC AREA AFFECTED AND ANNOTATE THE CHANGED PAGE OR CARD LISTED ON THE A PAGE WITH A VERTICAL LINE IN THE MARGIN NEXT TO THE CHANGED DATA, OPPOSITE THE BINDING. FOR DOUBLE COLUMN MATERIAL, MARK THE CENTER MARGIN WHEN THE INNER PARAGRAPH IS AFFECTED. NOTE THE IRAC NUMBER IN THE MARGIN.
THIS IRAC SHALL NOT BE REMOVED UNTIL RECEIPT OF FORMAL CHANGE PAGES.
B. FOR IRACS AFFECTING MANUALS THAT ARE ON DIGITAL MEDIA - AFFIX AN ADHESIVE LABEL TO THE DIGITAL MEDIA CASE ANNOTATED WITH THE APPLICABLE PUBLICATION NUMBER AND IRAC NUMBER. THE LABEL SHOULD BE POSITIONED TO ALLOW FOR ADDITIONAL IRACS AS THEY OCCUR AND SHOULD NOT COVER THE DATE OR DIGITAL MEDIA TITLE. MAINTAIN THE IRAC ON FILE UNTIL RECEIPT OF THE SUPERSEDING DIGITAL MEDIA.
C. SUBJECT IRAC SHALL BE INCORPORATED INTO APPLICABLE MANUAL NLT 12 MONTHS FROM THE DATE OF IRAC ISSUE.
D.//

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-----OFFICIAL INFORMATION DISPATCH FOLLOWS-----
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ZNR UUUUU
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FM COMNAVAIRSYSCOM PATUXENT RIVER MD//DRPO//
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FLTREADCEN EAST CHERRY POINT NC//V-22FST//
INFO COMNAVAIRSYSCOM PATUXENT RIVER MD//DRPO//
COMNAVAIRWARCENACDIV PATUXENT RIVER MD
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/COMNAVAIRSYSCOM PAX DRPO/-/-/-/-/USA/UNCLASSIFIED//
SUBJ/IRAC 008 TO 01-1A-20 DTD 30-JUL-2007//
REF/A/DOC/COMNAVAIRFORINST 4790.2B/15MAY2012//
REF/B/PUB/NAVAIR 00-25-100/30DEC2011//
REF/C/DOC/N65923-12-1791/05OCT2012//
NARR/REF A IS THE NAVAL AVIATION MAINTENANCE PROGRAM
REF B IS THE NAVAL AIR SYSTEMS COMMAND TECHNICAL MANUAL PROGRAM
REF C IS THE TECHNICAL PUBLICATION DEFICIENCY REPORT//
POC/CRUSE, MARIA/-/FLTREADCEN SOUTHWEST SAN/LOC:6.8.5.1
//TEL:619-545-3646//
GENTEXT/REMARKS/THIS MESSAGE WAS AUTO GENERATED FROM THE JDRS WEBSITE FOR NON-WEB SITE CAPABLE ORGANIZATIONS. THE REPORT WAS ORIGINATED BY:
------ FLTREADCEN EAST CHERRY POINT NC/V-22FST.
IF RESPONSE VIA WEB SITE IS NOT POSSIBLE, TO: LINE RECIPIENTS SHOULD ADDRESS RESPONSE DIRECTLY TO:
------ FLTREADCEN EAST CHERRY POINT NC/V-22FST WHEN APPROPRIATE. THIS DEFICIENCY REPORT WILL BE PROCESSED VIA THE JDRS WEBSITE. FOR FURTHER DETAILS OR REAL TIME STATUS VISIT THE JDRS WEB SITE AT: JDRS.MIL.
1. IRAC 008 TO 01-1A-20 DTD 30-JUL-2007
2. PURPOSE OF CHANGE: TO PROVIDE UPDATED INSTRUCTIONS.
3. DETAILED INFORMATION: PEN AND INK CHANGES TO THE TECHNICAL CONTENT OF A MANUAL ARE NOT AUTHORIZED. THE FOLLOWING TECHNICAL CONTENT CHANGE INFORMATION APPLIES TO THE FOLLOWING REFERENCED PAGES AND PARAGRAPHS OF THE SUBJECT MANUAL UNTIL THE FORMAL CHANGE IS RELEASED.
IN WP 009 00, PAGE 2, PARA 5, INSERT THE FOLLOWING TWO NOTES IMMEDIATELY FOLLOWING THE PARA 5 PROCEDURES HEADER AND PRIOR TO THE MATERIALS REQUIRED SECTION:
NOTE: THE TUBE BENDING INSTRUCTIONS IN THIS WP ARE GENERAL AND APPLICABLE EXCEPT WHEN OTHERWISE SPECIFIED IN THE MAINTENANCE MANUALS FOR THE PARTICULAR TYPE/MODEL/SERIES AIRCRAFT. WHEN TUBE BENDING PROCEDURES ARE SPECIFIED IN THE AIRCRAFT SPECIFIC MAINTENANCE MANUALS, THOSE PROCEDURES TAKE PRECEDENCE AND SHALL BE FOLLOWED.
NOTE:
V-22 HYDRAULIC TITANIUM AND CRES TUBES HAVING 901-08X-XXX SERIES PART NUMBERS SHALL BE BENT IN ACCORDANCE WITH I-LEVEL PROCEDURES AVAILABLE IN THE V-22 INTERACTIVE ELECTRONIC TECHNICAL MANUAL (IETM) OR IN ACCORDANCE WITH LOCAL DEPOT LEVEL ENGINEERING DIRECTIVES. THE SECTIONS OF THIS WP WHICH CAN BE REFERENCED WHILE MANUFACTURING V-22 TUBES WILL BE REFERENCED WITHIN THE IETM PROCEDURES OR THE DEPOT LEVEL ENGINEERING DIRECTIVES.

4. VALIDATED BY: MARIA CRUSE, NAWCAD, 6.8.5.1, 619-545-3646, 735-3646, MARIA.CRUSE@NAVY.MIL
5. RELATED INSTRUCTIONS:
A. FOR IRACS AFFECTING MANUALS IN PAPER COPY - MAINTAIN THIS IRAC WITH THE APPLICABLE MANUAL BY PLACING OR ATTACHING IT DIRECTLY BEHIND THE TITLE PAGE. MARK THE SPECIFIC AREA AFFECTED AND ANNOTATE THE CHANGED PAGE OR CARD LISTED ON THE A PAGE WITH A VERTICAL LINE IN THE MARGIN NEXT TO THE CHANGED DATA, OPPOSITE THE BINDING. FOR DOUBLE COLUMN MATERIAL, MARK THE CENTER MARGIN WHEN THE INNER PARAGRAPH IS AFFECTED. NOTE THE IRAC NUMBER IN THE MARGIN. THIS IRAC SHALL NOT BE REMOVED UNTIL RECEIPT OF FORMAL CHANGE PAGES.
B. FOR IRACS AFFECTING MANUALS THAT ARE ON DIGITAL MEDIA - AFFIX AN ADHESIVE LABEL TO THE DIGITAL MEDIA CASE ANNOTATED WITH THE APPLICABLE PUBLICATION NUMBER AND IRAC NUMBER. THE LABEL SHOULD BE POSITIONED TO ALLOW FOR ADDITIONAL IRACS AS THEY OCCUR AND SHOULD NOT COVER THE DATE OR DIGITAL MEDIA TITLE. MAINTAIN THE IRAC ON FILE UNTIL RECEIPT OF THE SUPERSEDING DIGITAL MEDIA.
C. SUBJECT IRAC SHALL BE INCORPORATED INTO APPLICABLE MANUAL NLT 12 MONTHS FROM THE DATE OF IRAC ISSUE.
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R 301749Z SEP 11 IRAC 007 TO 01-1A-20 DTD 30-JUL-2007// COMNAVAIRSYSCOM PATUXENT RIVER MD

TO AIG 423
FLTREADCEN EAST CHERRY POINT NC//V-22FST//

INFO COMNAVAIRSYSCOM PATUXENT RIVER MD//DRPO//
COMNAVAIRWARCENACDIV PATUXENT RIVER MD
FLTREADCEN EAST CHERRY POINT NC//V-22FST//

UNCLAS//N05600//
MSGID/GENADMIN/MIL-STD-6040(SERIES)/B.0.01.00
/COMNAVAIRSYSCOM PAX DRPO/-/-/-/-/USA/UNCLASSIFIED// SUBJ/IRAC 007 TO 01-1A-20 DTD 30-JUL-2007// REF/A/DOC/COMNAVAIRFORINST 4790.2A/10NOV2009// REF/B/PUB/NAVAIR 00-25-100/30DEC2010// REF/C/DOC/N65923-11-1007/02SEP2011// NARR/REF A IS THE NAVAL AVIATION MAINTENANCE PROGRAM REF B IS THE NAVAL AIR SYSTEMS COMMAND TECHNICAL MANUAL PROGRAM REF C IS THE TECHNICAL PUBLICATION DEFICIENCY REPORT// POC/CRUSE, MARIA/-/FLTREADCEN SOUTHWEST SAN/LOC:6.8.5.1 //TEL:619-545-3646// GENTEXT/REMARKS/THIS MESSAGE WAS AUTO GENERATED FROM THE JDRS WEBSITE FOR NON-WEB SITE CAPABLE ORGANIZATIONS. THE REPORT WAS ORIGINATED BY:
------ FLTREADCEN EAST CHERRY POINT NC/V-22FST.
IF RESPONSE VIA WEB SITE IS NOT POSSIBLE, TO: LINE RECIPIENTS SHOULD ADDRESS RESPONSE DIRECTLY TO:
------ FLTREADCEN EAST CHERRY POINT NC/V-22FST WHEN APPROPRIATE. THIS DEFICIENCY REPORT WILL BE PROCESSED VIA THE JDRS WEBSITE. FOR FURTHER DETAILS OR REAL TIME STATUS VISIT THE JDRS WEB SITE AT: JDRS.MIL.
1. IRAC 007 TO 01-1A-20 DTD 30-JUL-2007

2. PURPOSE OF CHANGE: TO PROVIDE HOSE DAMAGE LIMITS IN THE CURRENT VERSION OF THE MANUAL.

3. DETAILED INFORMATION: PEN AND INK CHANGES TO THE TECHNICAL CONTENT OF A MANUAL ARE NOT AUTHORIZED. THE FOLLOWING TECHNICAL CONTENT CHANGE INFORMATION APPLIES TO THE FOLLOWING REFERENCED PAGES AND PARAGRAPHS OF THE SUBJECT MANUAL UNTIL THE FORMAL CHANGE IS RELEASED.

IN WP 006 00, PAGE 3, REPLACE PARA 14 WITH THE FOLLOWING: 14. (AIR FORCE ONLY) AIRBORNE/AIRCRAFT HOSES: WHEN THE COTTON BRAID OR RUBBER COVER OF METAL-REINFORCED AIRBORNE HOSE IS FRAYED OR CHAFED IN SMALL AREAS AND THE METAL REINFORCEMENT WIRE BRAID IS NOT EXPOSED OR DAMAGED, THE FRAYED OR CHAFED AREAS MAY BE REPAIRED. REPAIR BY WRAPPING THE AREAS WITH TEFLON TAPE, P/N P5153-X OR TEFLON SPIRAL CHAFE GUARD. NOTE P/N P5153 IS A SPEC CONTROL NUMBER FOR TEFLON TAPE, AND THE X DESIGNATES DIFFERENT AVAILABLE WIDTHS. HOSES WITH SIZES 1/4 INCH TO 5/8 INCH OD, USE P/N 900628-4, NSN 9330-00-027-3345. HOSES WITH SIZES 3/4 INCH AND UP, USE P/N 900628-10, NSN 9330-00-863-8493. ENDS OF TEFLON TAPE OR TEFLON SPIRAL WRAPPING SHALL BE SECURED WITH LACING TAPE, P/N P5289-1, NSN 4020-01-477-7107.

IN WP 006 00, PAGE 3, REPLACE PARA 15 WITH THE FOLLOWING: 15. (AIR FORCE ONLY) NON-AIRBORNE HOSES. NON-AIRBORNE HOSES INSTALLED ON AEROSPACE GROUND EQUIPMENT WITH FRAYED OUTER COTTON BRAID OR THE RUBBER COVER OF METAL-REINFORCED HOSE ABRADED IN SMALL AREAS, AND THE METAL REINFORCEMENT IS NOT EXPOSED OR DAMAGED, MAY BE REMOVED FROM EQUIPMENT AND PROOF TESTED. THOSE HOSES WHICH SATISFACTORILY PASS THE PROOF TEST MAY BE REPAIRED AS IN PARAGRAPH 15.A. AND REINSTALLED ON EQUIPMENT. REPAIRED HOSES SHALL BE PROOF TESTED ANNUALLY.

IN WP 006 00, PAGE 3, INSERT NEW PARA 15.A. AS FOLLOWS: 15. A. (AIR FORCE ONLY) FRAYED OR CHAFED AREAS OF NON-AIRBORNE HOSES MAY BE REPAIRED BY WRAPPING THE AREAS IN TEFLON SPIRAL CHAFE GUARD. HOSES WITH SIZES 1/4 INCH TO 5/8 INCH OD, USE P/N 900628-4, NSN 9330-00-027-3345. HOSES WITH SIZES 3/4 INCH AND UP, USE P/N 900628-10, NSN 9330-00-836-8493. TEFLON SPIRAL CHAFE GUARD WILL BE SECURED OVER THE HOSE BY USE OF TY WRAP, P/N MS3367-1-9, NSN 5975-00-074-2072 OR SHRINK TUBING, P/N M23053/5-112-5, NSN 5970-00-781-6836.

4. VALIDATED BY: M.K. CRUSE, FRCSW, 6.8.5.1, 619-545-3646, 735-3646, MARIA.CRUSE@NAVY.MIL

5. RELATED INSTRUCTIONS:

A. FOR IRACS AFFECTING MANUALS IN PAPER COPY - MAINTAIN THIS IRAC WITH THE APPLICABLE MANUAL BY PLACING OR ATTACHING IT DIRECTLY BEHIND THE TITLE PAGE. MARK THE SPECIFIC AREA AFFECTED AND ANNOTATE THE CHANGED PAGE OR CARD LISTED ON THE A PAGE WITH A VERTICAL LINE IN THE MARGIN NEXT TO THE CHANGED DATA, OPPOSITE THE BINDING. FOR DOUBLE COLUMN MATERIAL, MARK THE CENTER MARGIN WHEN THE INNER PARAGRAPH IS AFFECTED. NOTE THE IRAC NUMBER IN THE MARGIN.THIS IRAC SHALL NOT BE REMOVED UNTIL RECEIPT OF FORMAL CHANGE PAGES.

B. FOR IRACS AFFECTING MANUALS THAT ARE ON DIGITAL MEDIA - AFFIX AN ADHESIVE LABEL TO THE DIGITAL MEDIA CASE ANNOTATED WITH THE APPLICABLE PUBLICATION NUMBER AND IRAC NUMBER. THE LABEL SHOULD BE POSITIONED TO ALLOW FOR ADDITIONAL IRACS AS THEY OCCUR AND SHOULD NOT COVER THE DATE OR DIGITAL MEDIA TITLE. MAINTAIN THE IRAC ON FILE UNTIL RECEIPT OF THE SUPERSEDING DIGITAL MEDIA.

C. SUBJECT IRAC SHALL BE INCORPORATED INTO APPLICABLE MANUAL NLT 12 MONTHS FROM THE DATE OF IRAC ISSUE.

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R 251618Z FEB 10 INTERIM RAPID ACTION CHANGE (IRAC) 6 TO TECHNICAL MANUAL
FLTREADCEN EAST CHERRY POINT NC

TO AIG 428
AL 428
AIG 165
AL 165

INFO FLTREADCEN EAST CHERRY POINT NC
FLTREADCEN SOUTHWEST SAN DIEGO CA

UNCLAS
PASS TO OFFICE CODES:
FM FLTREADCEN EAST CHERRY PT NC
INFO FLTREADCEN EAST CHERRY POINT NC//
NATEC SAN DIEGO CA//3.3//
FLTREADCEN SOUTHWEST SAN DIEGO CA//6.8.5.1// SECINFO/U/-//
MSGID/GENADMIN,USMTF,2008/FLTREADCEN EAST CHERRY PT NC// SUBJ/INTERIM RAPID ACTION CHANGE (IRAC) 6 TO TECHNICAL MANUAL /NA 01-1A-20, T.O. 42E1-1-1, OF 30 JULY 2007// REF/A/MSGID:DOC/NA 01-1A-20, T.O. 42E1-1-1/YMD:20070730// AMPN/REF A IS THE AVIATION HOSE AND TUBE MAINTENANCE MANUAL, ORGANIZATIONAL, INTERMEDIATE AND DEPOT LEVEL MAINTENANCE.// POC/M. GRAVES/ENGR/UNIT:435/NAME:FRC EAST CHERRY POIN /TEL:(252)464-5617/EMAIL:MICHAEL.D.GRAVES@NAVY.MIL//
GENTEXT/REMARKS/1. RESPONSIBLE CODE: FLTREADCEN EAST CHERRY PT NC, SUBSYSTEMS ENGINEERING, CODE 4.3.5, M. GRAVES, PRIPHN DSN 451-5617, EMAIL: MICHAEL.D.GRAVES@NAVY.MIL. GENERAL SERIES PUBLICATIONS MANAGER , CODE 6.8.5.1, KATHLEEN CRUSE, PRIPHN DSN 735-3646, EMAIL: MARIA.CRUSE@NAVY.MIL.
2. CONDITION AND PURPOSE OF CHANGE: DURING RECENT REVISION OF SUBJECT MANUAL, INFORMATION RELATED TO AIR FORCE MANUFACTURE OF EGRESS SYSTEM HOSES WAS INADVERTANTLY OMITTED. PURPOSE OF THIS CHANGE IS TO INCREASE MISSION CAPABILITY AND READINESS BY ADDING EGRESS SYSTEM HOSE MANUFACTURING INFORMATION INTO NA 01-1A-20/T.O. 42E1-1-1.
3. DETAILED INFORMATION: PEN AND INK CHANGES TO THE TECHNICAL CONTENT OF A MANUAL ARE NOT AUTHORIZED. THE FOLLOWING TECHNICAL CONTENT CHANGE INFORMATION APPLIES TO THE FOLLOWING REFERENCED PAGES AND PARAGRAPHS OF REF A UNTIL THE FORMAL CHANGE IS RELEASED.
A. THIS IRAC 6 SUPERSEDES DTG 191309Z FEB 10 AND DTG 081949Z DUE TO INCORRECT NUMBERING.
B. WP 004 04, PAGE 2, PARAGRAPH 3, BELOW THE WARNING STATEMENTS, ADD THE FOLLOWING NOTE: NOTE: (AIR FORCE ONLY) HOSE ASSEMBLIES INTENDED FOR USE IN PERSONNEL EJECTION EGRESS SYSTEMS ARE TO BE FIELD MANUFACTURED IN ACCORDANCE WITH THE MACHINE TOOL ASSEMBLY PROCEDURES, WP 004 04, PARA 11 THROUGH 13. MACHINE TOOL ASSEMBLED HOSES ASSEMBLIES UTILIZING MILITARY STANDARD SCREW-TOGETHER FITTINGS ARE AUTHORIZED REPLACEMENTS FOR HOSE ASSEMBLIES USED IN PERSONNEL EJECTION EGRESS SYSTEMS. THE HAND TOOL METHOD DESCRIBED IN PARAGRAPH 5 IS A SECONDARY PROCEDURE FOR FIELD MANUFACTURE FOR ALL SYSTEMS AND SHOULD BE USED ONLY AS A LAST RESORT TO PRECLUDE AIRCRAFT/EQUIPMENT NORS/ANORS STATUS.
C. WP 004 04, PAGE 2, PARAGRAPH 4, BELOW THE CAUTION STATEMENT, ADD THE FOLLOWING CAUTION: CAUTION: (AIR FORCE ONLY) END FITTINGS SHALL NOT BE INSTALLED ON USED AIRCRAFT HOSE, SPECIFICATION MIL-DTL-27267 (USAF) AND/OR MIL-DTL-25579 (USAF).

D. WP 004 04, PAGE 2, PARAGRAPH 4, BELOW THE CAUTION STATEMENTS, ADD THE FOLLOWING NOTE: NOTE: (AIR FORCE ONLY) PRIOR TO ATTACHING END FITTINGS TO BULK HOSE FOR USE IN EGRESS SYSTEMS, PASS A STEEL BALL OR SMOOTH SECTION OF ROD THROUGH THE INSIDE DIAMETER OF THE HOSE. BALL AND ROD DIMENSION IS TO BE APPROXIMATELY THE SAME AS THE INSIDE DIAMETER OF THE TUBE BEING TESTED WITH CLEARANCE TO PREVENT SCORING OR SCRATCHING THE INTERNAL SURFACE OF THE TUBE. WHEN A ROD IS USED, THE END INSERTED IN THE TUBE SHALL BE ROUNDED AND FREE OF ALL BURRS. THIS PROCEDURE SHALL BE ACCOMPLISHED TO CONFIRM THERE IS NO FOREIGN OBJECT OR OTHER RESTRICTION IN THE RAW MATERIAL STOCK.

E. WP 004 04, PAGE 2, PARAGRAPH 4, BELOW THE CAUTION STATEMENTS, ADD THE FOLLOWING NOTE: NOTE: (AIR FORCE ONLY) BALLISTIC HOSES FOR EGRESS SYSTEMS ARE NOT REUSABLE AND SHALL BE REPLACED AFTER ANY ACTIVATION OF EGRESS SYSTEM OR PORTION THEREOF.

F. WP 004 04, PAGE 20, TABLE 3:

(1) INSERT NEW COLUMNAR LISTING FOR -4 BALLISTICS HOSE PROOF PRESSURE TEST REQUIREMENTS: SIZE -4 (NOTE 6), OPERATING PRESSURE: 1500 PLUS, PROOF PRESSURE: 6000, BURST PRESSURE: 12000, HIGH TEMPERATURE BURST PRESSURES: 7000, MINIMUM BEND RADIUS (IN): 2.00.

(2) INSERT NEW COLUMNAR LISTING FOR -5 BALLISTICS HOSE PROOF PRESSURE TEST REQUIREMENTS: SIZE -5 (NOTE 6), OPERATING PRESSURE: 1500 PLUS, PROOF PRESSURE: 6000, BURST PRESSURE: 10000, HIGH TEMPERATURE BURST PRESSURES: 6500, MINIMUM BEND RADIUS (IN): 2.00.

(3) ADD A NEW NOTE 6 TO THE LIST OF NOTES ASSOCIATED WITH TABLE 3: NOTE 6: BALLISTIC HOSE FOR EGRESS SYSTEMS ONLY (AIR FORCE ONLY).

4. VALIDATED BY: FLTREADCEN EAST CHERRY POINT NC, CODE 4.3.5, M. GRAVES, PRIPHN 451-5617.

5. RELATED INSTRUCTIONS:

A. FOR PAPER COPY - MAINTAIN THIS IRAC WITH THE APPLICABLE MANUAL BY PLACING OR ATTACHING IT DIRECTLY BEHIND THE TITLE PAGE. MARK THE SPECIFIC CHANGE AREA IN THE MARGIN OF EACH PAGE AFFECTED WITH A VERTICAL LINE, AND INCLUDE THE IRAC NUMBER AND DATE TIME GROUP (DTG) OF THE IRAC MSG. THIS IRAC SHALL NOT BE REMOVED UNTIL RECEIPT OF THE FORMAL CHANGE PAGES.

B. FOR IRACS AFFECTING MANUALS ON CD-ROM: AFFIX AN ADHESIVE LABEL TO THE CD-ROM CASE, ANNOTATED WITH THE APPLICABLE PUBLICATION NUMBER, IRAC NUMBER AND DTG OF THE IRAC MSG. THE LABEL SHOULD BE POSITIONED TO ALLOW FOR ADDITIONAL UPDATES AS THEY OCCUR. MAINTAIN THE IRAC ON FILE UNTIL RECEIPT OF THE SUPERSEDING CD-ROM.

C. SUBJ IRAC SHALL BE INCORPORATED INTO APPLICABLE MANUAL NO LATER THAN 12 MONTHS AFTER IRAC ISSUE DATE BY FRCSW NORTH ISLAND, CODE 6.8.5.1.

D. TO ASSIST US IN MEASURING OUR PERFORMANCE, PLEASE PROVIDE FEEDBACK ON THE QUALITY OF THIS PRODUCT BY ACCESSING HTTP:/WWW.NADEPCP.NAVY.MIL/FEEDBACK/PRODUCTCOMMENTS.CFM./PASS TO: COMNAVAIRSYSCOM PATUXENT RIVER MD 4.4.3.2, 3.1.2E, 4.1.1.2; COGARD AR SC ELIZABETH CITY NC H60ENG; CDRCCAD CORPUS CHRISTI TX SDSCC-QQT, SIOCC-N-L, SIOCC-LS-BG; COMNAVAIRPAC SAN DIEGO CA N421G3; COMNAVAIRLANT NORFOLK VA N421G3, USDAO TEL AVIV IS JJJ; ODC ANKARA TU ARS; AIT TAIPEI TW JJJ; NATEC SAN DIEGO; NATEC SAN DIEGO CA 3.3.A73. // BT

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R 081949Z FEB 10 (CORRECTED COPY) INTERIM RAPID ACTION CHANGE (IRAC) 5 TO FLTREADCEN EAST CHERRY POINT NC

TO AIG 165
AL 165
AIG 428
AL 428

INFO FLTREADCEN EAST CHERRY POINT NC
FLTREADCEN SOUTHWEST SAN DIEGO CA

UNCLAS
PASS TO OFFICE CODES:
FM FLTREADCEN EAST CHERRY PT NC
INFO FLTREADCEN EAST CHERRY POINT NC//
NATEC SAN DIEGO CA//3.3//
FLTREADCEN SOUTHWEST SAN DIEGO CA//6.8.5.1// SECINFO/U/-//
MSGID/GENADMIN,USMTF,2008/FLTREADCEN EAST CHERRY PT NC// SUBJ/(CORRECTED COPY) INTERIM RAPID ACTION CHANGE (IRAC) 5 TO TECHNICAL MANUAL NA 01-1A-20, T.O. 42E1-1-1, OF 30 JULY 2007// REF/A/MSGID:DOC/NA 01-1A-20, T.O. 42E1-1-1/YMD:20070730// AMPN/REF A IS THE AVIATION HOSE AND TUBE MAINTENANCE MANUAL, ORGANIZATIONAL, INTERMEDIATE AND DEPOT LEVEL MAINTENANCE.// POC/M. GRAVES/ENGR/UNIT:435/NAME:FRC EAST CHERRY POIN /TEL:(252)464-5617/EMAIL:MICHAEL.D.GRAVES@NAVY.MIL//
GENTEXT/REMARKS/1. RESPONSIBLE CODE: FLTREADCEN EAST CHERRY PT NC, SUBSYSTEMS ENGINEERING, CODE 4.3.5, M. GRAVES, PRIPHN DSN 451-5617, EMAIL: MICHAEL.D.GRAVES@NAVY.MIL. GENERAL SERIES PUBLICATIONS MANAGER , CODE 6.8.5.1, KATHLEEN CRUSE, PRIPHN DSN 735-3646, EMAIL: MARIA.CRUSE@NAVY.MIL.
2. CONDITION AND PURPOSE OF CHANGE: DURING RECENT REVISION OF SUBJECT MANUAL, INFORMATION RELATED TO AIR FORCE MANUFACTURE OF EGRESS SYSTEM HOSES WAS INADVERTANTLY OMITTED. PURPOSE OF THIS CHANGE IS TO INCREASE MISSION CAPABILITY AND READINESS BY ADDING EGRESS SYSTEM HOSE MANUFACTURING INFORMATION INTO NA 01-1A-20/T.O.42E1-1-1.
3. DETAILED INFORMATION: PEN AND INK CHANGES TO THE TECHNICAL CONTENT OF A MANUAL ARE NOT AUTHORIZED. THE FOLLOWING TECHNICAL CONTENT CHANGE INFORMATION APPLIES TO THE FOLLOWING REFERENCED PAGES AND PARAGRAPHS OF REF A UNTIL THE FORMAL CHANGE IS RELEASED.
A. THIS IRAC 5 SUPERSEDES DTG 081949Z FEB 10 DUE TO INCORRECT NUMBERING.
B. WP 004 04, PAGE 2, PARAGRAPH 3, BELOW THE WARNING STATEMENTS, ADD THE FOLLOWING NOTE: NOTE: (AIR FORCE ONLY) HOSE ASSEMBLIES INTENDED FOR USE IN PERSONNEL EJECTION EGRESS SYSTEMS ARE TO BE FIELD MANUFACTURED IN ACCORDANCE WITH THE MACHINE TOOL ASSEMBLY PROCEDURES, WP 004 04, PARA 11 THROUGH 13. MACHINE TOOL ASSEMBLED HOSES ASSEMBLIES UTILIZING MILITARY STANDARD SCREW-TOGETHER FITTINGS ARE AUTHORIZED REPLACEMENTS FOR HOSE ASSEMBLIES USED IN PERSONNEL EJECTION EGRESS SYSTEMS. THE HAND TOOL METHOD DESCRIBED IN PARAGRAPH 5 IS A SECONDARY PROCEDURE FOR FIELD MANUFACTURE FOR ALL SYSTEMS AND SHOULD BE USED ONLY AS A LAST RESORT TO PRECLUDE AIRCRAFT/EQUIPMENT NORS/ANORS STATUS.
C. WP 004 04, PAGE 2, PARAGRAPH 4, BELOW THE CAUTION STATEMENT, ADD THE FOLLOWING CAUTION: CAUTION: (AIR FORCE ONLY) END FITTINGS SHALL NOT BE INSTALLED ON USED AIRCRAFT HOSE, SPECIFICATION MIL-DTL-27267 (USAF) AND/OR MIL-DTL-25579 (USAF).

D. WP 004 04, PAGE 2, PARAGRAPH 4, BELOW THE CAUTION STATEMENTS, ADD THE FOLLOWING NOTE: NOTE: (AIR FORCE ONLY) PRIOR TO ATTACHING END FITTINGS TO BULK HOSE FOR USE IN EGRESS SYSTEMS, PASS A STEEL BALL OR SMOOTH SECTION OF ROD THROUGH THE INSIDE DIAMETER OF THE HOSE. BALL AND ROD DIMENSION IS TO BE APPROXIMATELY THE SAME AS THE INSIDE DIAMETER OF THE TUBE BEING TESTED WITH CLEARANCE TO PREVENT SCORING OR SCRATCHING THE INTERNAL SURFACE OF THE TUBE. WHEN A ROD IS USED, THE END INSERTED IN THE TUBE SHALL BE ROUNDED AND FREE OF ALL BURRS. THIS PROCEDURE SHALL BE ACCOMPLISHED TO CONFIRM THERE IS NO FOREIGN OBJECT OR OTHER RESTRICTION IN THE RAW MATERIAL STOCK.

E. WP 004 04, PAGE 2, PARAGRAPH 4, BELOW THE CAUTION STATEMENTS, ADD THE FOLLOWING NOTE: NOTE: (AIR FORCE ONLY) BALLISTIC HOSES FOR EGRESS SYSTEMS ARE NOT REUSABLE AND SHALL BE REPLACED AFTER ANY ACTIVATION OF EGRESS SYSTEM OR PORTION THEREOF.

F. WP 004 04, PAGE 20, TABLE 3:

(1) INSERT NEW COLUMNAR LISTING FOR -4 BALLISTICS HOSE PROOF PRESSURE TEST REQUIREMENTS: SIZE -4 (NOTE 6), OPERATING PRESSURE: 1500 PLUS, PROOF PRESSURE: 6000, BURST PRESSURE: 12000, HIGH TEMPERATURE BURST PRESSURES: 7000, MINIMUM BEND RADIUS (IN): 2.00.

(2) INSERT NEW COLUMNAR LISTING FOR -5 BALLISTICS HOSE PROOF PRESSURE TEST REQUIREMENTS: SIZE -5 (NOTE 6), OPERATING PRESSURE: 1500 PLUS, PROOF PRESSURE: 6000, BURST PRESSURE: 10000, HIGH TEMPERATURE BURST PRESSURES: 6500, MINIMUM BEND RADIUS (IN): 2.00.

(3) ADD A NEW NOTE 6 TO THE LIST OF NOTES ASSOCIATED WITH TABLE 3: NOTE 6: BALLISTIC HOSE FOR EGRESS SYSTEMS ONLY (AIR FORCE ONLY).

4. VALIDATED BY: FLTREADCEN EAST CHERRY POINT NC, CODE 4.3.5, M. GRAVES, PRIPHN 451-5617.

5. RELATED INSTRUCTIONS:

A. FOR PAPER COPY - MAINTAIN THIS IRAC WITH THE APPLICABLE MANUAL BY PLACING OR ATTACHING IT DIRECTLY BEHIND THE TITLE PAGE. MARK THE SPECIFIC CHANGE AREA IN THE MARGIN OF EACH PAGE AFFECTED WITH A VERTICAL LINE, AND INCLUDE THE IRAC NUMBER AND DATE TIME GROUP (DTG) OF THE IRAC MSG. THIS IRAC SHALL NOT BE REMOVED UNTIL RECEIPT OF THE FORMAL CHANGE PAGES.

B. FOR IRACS AFFECTING MANUALS ON CD-ROM: AFFIX AN ADHESIVE LABEL TO THE CD-ROM CASE, ANNOTATED WITH THE APPLICABLE PUBLICATION NUMBER, IRAC NUMBER AND DTG OF THE IRAC MSG. THE LABEL SHOULD BE POSITIONED TO ALLOW FOR ADDITIONAL UPDATES AS THEY OCCUR. MAINTAIN THE IRAC ON FILE UNTIL RECEIPT OF THE SUPERSEDING CD-ROM.

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#0001

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

LIST OF TECHNICAL PUBLICATIONS DEFICIENCY REPORTS INCORPORATED

AVIATION HOSE AND TUBE MANUAL

1. The TPDRs listed below have been incorporated in this issue.

IDENTIFICATION NUMBER/ QA SEQUENCE NUMBER	LOCATION
08344-04-0004	Pg A
08344-04-0005	Pg A
08981-02-0019	Pg A
21247-02-0032	Pg A
44328-02-0061	Pg A
FITAM-03-0133	WP011 00
00216-99-0013	WP004 00, Pg 13
52814-98-0035	WP004 00, Pg 13
30340-04-1064	WP008 00, Pg 3
52814-04-0038	WP004 00, Pg 2
53914-03-0010	WP004 00, Pg 9
55242-06-0020	WP004 00, Pg 5
69190-07-0046	WP011 00, Pg 3

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WARNINGS APPLICABLE TO HAZARDOUS MATERIALS

Warnings for hazardous materials listed in this manual are designed to warn personnel of hazards associated with such items when they come in contact with them by actual use. Additional information related to hazardous materials is provided in OPNAVINST 5100.23, Navy Occupational Safety and Health (NAVOSH) Program Manual, NAVSUPINST 5100.27, Navy Hazardous Material Control Program, and the DOD 6050.5, Hazardous Materials Information System (HMIS) series publications. For each hazardous material used within the Navy, a Material Safety Data Sheet (MSDS) is required to be provided and available for review by users. Consult your local safety and health staff concerning any questions on hazardous chemicals, MSDSs, personal protective equipment requirements and appropriate handling and emergency procedures and disposal guidance.

Complete warnings for hazardous materials referenced in this manual are identified by use of an icon, nomenclature and specification or part number of the material, and a numeric identifier. The numeric identifiers have been assigned to the hazardous materials in the order of their appearance in the manual. Each hazardous material is assigned only one numeric identifier. Repeated use of a specific hazardous material references the numeric identifier assigned at its initial appearance. The approved icons and their applications are shown in the Explanation of Hazardous Materials.

In the text of the manual, the caption “WARNING” will not be used for hazardous materials. Such warnings will be identified by an icon and numeric identifier. The material nomenclature will also be provided. The user is directed to refer to the corresponding numeric identifier listed in this WP under the heading HAZARDOUS MATERIALS WARNINGS for the complete warning applicable to the hazardous material.

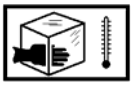
EXPLANATION OF HAZARDOUS SYMBOLS

Biological

The abstract symbol shows a material that may contain bacteria or viruses that present a health hazard.

Chemical

The symbol of drops of a liquid burning a hand shows a material that causes burns to human skin or tissue.



Cryogenic

The symbol of a hand in a block of ice shows a material is so cold it will burn your skin on contact.

Explosion

The rapidly expanding symbol shows that the material may explode if subjected to high temperature, sources of ignition, or high pressure.

Eye Protection

The symbol of a person wearing goggles shows a material that can injure your eyes.

EXPLANATION OF HAZARDOUS SYMBOLS (Cont)

Fire

The symbol of a fire shows that a material can ignite and burn you.

Poison

The symbol of a skull and crossbones shows a material that is highly toxic and can be a danger to life and health.

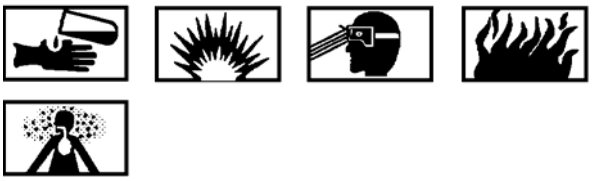
Radiation

The symbol of three circular wedges shows that the material emits radioactive energy and can injure human tissue or organs.

Vapor

The symbol of a human figure in a cloud shows that breathing this material can present a health hazard.

HAZARDOUS MATERIALS WARNINGS

Index	Material	Warning
1	Hydraulic Fluid, MIL-PRF-83282 	Hydraulic fluid is toxic. Protection: chemical splash proof goggles and gloves. Keep fluid off skin, eyes and clothes. Wear gloves and oil-impervious apron when feasible.
2	Hydraulic Fluid, MIL-H-81019 	If hydraulic fluid is decomposed by heat, toxic gases are released. Prolonged contact with liquid or mist can cause dermatitis and irritation to skin and eyes. If there is any prolonged contact with skin, wash contacted area with soap and water. If prolonged contact with mist is likely, wear approved respirator. Hydraulic fluid is toxic if swallowed. Wash hands after handling and before eating, drinking or smoking.
3	Gasket Sealing Compound, MIL-S-45180, Type II 	Gasket sealing compound is an eye and central nervous system irritant. Use with adequate ventilation. Avoid prolonged breathing of vapors. Keep away from heat, sparks and flame. Protection: chemical goggles, rubber gloves.
4	Aircraft Exterior Cleaning Compound, MIL-PRF-85570, Type II 	Aircraft exterior cleaning compound is irritating to the eyes and skin. Prolonged contact may cause dermatitis. Protection: gloves, chemical resistant goggles, faceshield and good ventilation. Keep container closed. Keep sparks, flames, and heat away. Keep compound off skin, eyes, and clothing. Do not breath vapors. Ensure good personal hygiene prior to eating, drinking, or smoking.
5	Adhesive, MIL-A-46146, Type II 	Adhesive is combustible at temperatures above 250°F and is an irritant to skin and eyes. Keep away from heat, sparks, and flame. Avoid contact with skin and eyes. Do not breath vapors. Protection: rubber gloves, chemical resistant goggles, and local ventilation.
6	Non-Ionic Detergent, MIL-D-16791 	Non-Ionic detergent is a skin and eye irritant. Avoid contact with skin and eyes. Store away from heat source. Protection: gloves, goggles.

HAZARDOUS MATERIALS WARNINGS (Cont)

Index	Material	Warning
7	Trichlorotrifluoroethane (Freon), MIL-C-81302	Trichlorotrifluoroethane (freon) is a skin and eye irritant. Do not spray or use in confined spaces and/or areas. Protection: gloves, eye protection.
8	Nitrogen, A-A-59503	Nitrogen is non-toxic but is a simple asphyxiate which in high concentration may reduce the oxygen content of the air sufficiently to cause breathing difficulties. Avoid contact with cryogenic liquid. Protection: special gloves, clothing for cryogenic.
9	Epoxy Polyamide Primer, MIL-PRF-23377	Epoxy polyamide primer is toxic and flammable. Prevent prolonged or repeated breathing of vapors or spray mist as it may cause allergic reactions. Avoid contact with skin and eyes. Store tightly in a cool, dry, well ventilated area. Launder contaminated clothing before reuse. Protection: full face piece continuous-flow supplied air respirator, gloves, chemical resistant goggles, faceshield, protective skin compound, protective clothing required during spraying operations.
10	Epoxy Primer, MIL-PRF-85582	Epoxy primer is toxic and flammable. Prevent prolonged or repeated breathing of vapors or spray mist as it may cause allergic reactions. Avoid contact with skin and eyes. Store tightly in a cool, dry, well ventilated area. Launder contaminated clothing before reuse. Protection: full face piece continuous-flow supplied air respirator, gloves, chemical resistant goggles, faceshield, protective skin compound, protective clothing required during spraying operations.
11	Sealant, AMS-S-8802	Sealant is toxic and flammable. Avoid prolonged breathing of vapors and prolonged or repeated skin contact. Keep away from heat, sparks, and open flame. Use with adequate ventilation to prevent vapor buildup. Protection: rubber gloves, chemical resistant goggles, and protective skin compound.

HAZARDOUS MATERIALS WARNINGS (Cont)

Index	Material	Warning
12	Corrosion Preventive Compound, MIL-PRF-16173, Class II, Grade 2	Corrosion preventive compound is toxic and combustible. May cause skin and eye irritation. Overexposure may cause dizziness and narcosis. Protection: chemical splash proof goggles, gloves and good ventilation.
		
13	General Purpose Lubricating Oil, MIL-PRF-32033	General purpose lubricating oil is toxic and flammable. Avoid contact with skin or eyes. Keep away from heat, sparks and flame. Do not re-use containers. Protection: rubber gloves, chemical goggles.
		
14	Acetone, A-A-59281/ASTM D329	Acetone, ASTM D329 is flammable. Do not breathe vapors. Do not use near heat, sparks, open flames, or any other source of ignition. Use only in well-ventilated area. Do not allow contact with skin or eyes. PPE: Butyl rubber gloves, goggles. Consult the applicable Material Safety Data Sheet (MSDS) and local Occupational Safety and Health (OSH) regulations for appropriate safety precautions.
		
15	Zinc Chromate Primer Coating, TT-P-1757	Zinc chromate primer coating is toxic and flammable. Avoid breathing vapors. Wash hands thoroughly after handling and before eating and smoking. Keep away from heat, sparks, and flame. Use adequate ventilation. Protection: full face piece continuous-flow supplied air respirator, gloves, chemical resistant goggles, faceshield, and protective clothing required during spraying operations.
		
16	Thinner, MIL-T-81772	Thinner is toxic and flammable. Avoid prolonged breathing of vapors. Use in adequate ventilated area. Protection: gloves, goggles.
		

HAZARDOUS MATERIALS WARNINGS (Cont)

Index	Material	Warning
17	Grease, Plug Valve, SAE AMS-G-6032 	Grease, SAE AMS-G-6032 may irritate the skin upon prolonged exposure. Avoid contact with the eyes and skin. PPE: Rubber gloves, safety goggles. Consult the applicable Material Safety Data Sheet (MSDS) and local Occupational Safety and Health (OSH) regulations for additional information.
18	Lubricating Oil, MIL-PRF-23699 	Lubricating oil, MIL-PRF-23699 can irritate skin or eyes upon contact. May contain a neurotoxin that can be absorbed through the intact skin. Symptoms of overexposure include tingling or numbness in hands or feet. Wear nitrile gloves, chemical protective goggles. Consult the applicable Material Safety Data Sheet (MSDS) and local Occupational Safety and Health (OSH) regulations for additional information.
19	Grease, Pneumatic System, SAE AMS-G-4343 	Pneumatic system grease, SAE AMS-G-4343 may irritate eyes. May irritate skin after prolonged or repeated contact. Wear safety glasses and nitrile gloves. Consult the applicable Material Safety Data Sheet (MSDS) and local Occupational Safety and Health (OSH) regulations for additional information.
20	Dry Cleaning Solvent, MIL-PRF-680 	Dry Cleaning Solvent, MIL-PRF-680, may cause eye and skin irritation. Overexposure may cause dizziness and other central nervous system effects. Wear nitrile gloves and chemical splash proof protective goggles. Consult the applicable Material Safety Data Sheet (MSDS) and local Occupational Safety and Health (OSH) regulations for appropriate safety precautions.
21	Ethyl Alcohol AA-51693 	AA-51693 Ethyl alcohol is flammable and irritating to the skin, eyes, and respiratory tract. Do not use in confined spaces. Avoid breathing vapors. Wear chemical splash proof goggles and butyl gloves. Consult the applicable Material Safety Data Sheet (MSDS) and local Occupational Safety and Health (OSH) regulations for additional information.

HAZARDOUS MATERIALS WARNINGS (Cont)

Index	Material	Warning
22	Isopropyl Alcohol TT-I-735 	TT-I-735 Isopropyl Alcohol is flammable. Do not use near open flame or other sources of ignition. May irritate skin and eyes. Inhalation may cause dizziness, headaches and irritation to respiratory tract. Wear chemical splash proof goggles and gloves. Consult the applicable Material Safety Data Sheet (MSDS) and local Occupational Safety and Health (OSH) regulations for additional information.
23	Cleaning Compound MIL-PRF-87937 Type II 	Cleaning Compound Mil-C-87936 Type II is irritating to the skin and eyes and poses a slight inhalation hazard. PPE: Rubber gloves, face shield or goggles. Consult the applicable Material Safety Data Sheet (MSDS) and local Occupational Safety and Health (OSH) regulations for additional information.

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

ALPHABETICAL INDEX

AVIATION HOSE AND TUBE MANUAL

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Dynatube Fittings	013 00
Fuel and Hydraulic System Protective Closures (NAVY USE ONLY)	007 00
Permaswage Fittings	011 00
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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

CROSS-REFERENCE AND PROCUREMENT

AVIATION HOSES AND TUBES

Reference Material

None

Alphabetical Index

Subject	Page No.
Aeroquip Rynglok® to Permaswage Part Number Cross-Reference	2
Cancelled Specification to Replaced Specification Cross-Reference	2
General	2
Procurement Information for Caps and Plugs	2

Record of Applicable Technical Directives

None

1. GENERAL.

2. This work package provides cross-reference and procurement information for aviation hoses and tubes.

3. AEROQUIP RYNGLOK® TO PERMASWAGE PART NUMBER CROSS-REFERENCE.

4. Tables 1 through 10 provide cross-reference information for Aeroquip Ryngloк® to Permaswage fittings. Additional information for these fittings can be found in WP017 00 and WP011 00, respectively.

5. CANCELLED SPECIFICATION TO REPLACED SPECIFICATION CROSS-REFERENCE.

6. Tables 11 through 14 provide cross-reference information for cancelled specifications to replaced specifications.

7. PROCUREMENT INFORMATION FOR CAPS AND PLUGS.

8. Tables 15 through 20 provide procurement information for caps and plugs.

Table 1. Permanent Fittings

Configuration	Permaswage P/N (Note 1)	Rynglok® P/N
Union	D10036-(XX)	R80101T(XX)
Union	D10136-(XX)	R80101T(XX)
Union, Reducer	D10045-(XX)(XX)	R80151T(XX)(XX)
45° Elbow	D10090-(XX)	R80102T(XX)
45° Elbow, Reducer	D10323-(XX)	R80152T(XX)(XX)
90° Elbow	D9856-(XX)	R80103T(XX)
90° Elbow	D10256-(XX)	R80103T(XX)
90° Elbow, Reducer	D10035-(XX)(XX)	R80153T(XX)(XX)
90° Elbow, Reducer	D10235-(XX)(XX)	R80153T(XX)(XX)
Tee Assembly	D9855-(XX)	R80104T(XX)
Tee Assembly	D10255-(XX)	R80104T(XX)
Tee Assembly, Reducer	D10023-(XX)(XX)(XX)	R80154T(XX)
Tee Assembly, Reducer	D10223-(XX)(XX)(XX)	R80154T(XX)
Cross	D9854-(XX)	R80105T(XX)
	D10254-(XX)	R80105T(XX)
Cross, Reducer	D10033-(XX)(XX)(XX)(XX)	R80155T(XX)(XX)(XX)(XX)

Notes: 1. Permaswage fittings starting with “D” are rated only to 3,000 PSI and are not an equivalent to Rynglok® “R8” fittings.

Table 2. Permanent to Lipseal Swivel Nut Fittings

Configuration	Permaswage P/N (Note 1)	Rynglok® P/N
Straight	D11200-(XX)	R81101T(XX)
Straight	DD00200A-(XX)	R81201T(XX)
Straight, Reducer	D11300-(XX)(XX)	R81151T(XX)(XX)
45° Elbow	D11055A-(XX)	R81102T(XX)
45° Elbow, Reducer		R81152T(XX)(XX)
90° Elbow	D11009-(XX)	R81103T(XX)
90° Elbow, Reducer		R81153T(XX)(XX)
Tee, Run Adapter	D11056A-(XX)	R81104T(XX)
Tee, Run Adapter, Reducer	D11119A-(XX)(XX)(XX)	R81154T(XX)(XX)(XX)
Tee, Side Adapter	D11057A-(XX)	R81106T(XX)
Tee, Side Adapter, Reducer		

Notes: 1. Permaswage fittings starting with “D” are rated only to 3,000 PSI and are not an equivalent to Rynglok® “R8” fittings.

Table 3. Permanent to Male Lipseal Nut Fittings

Configuration	Permaswage P/N (Note 1)	Rynglok® P/N
Straight	D11007-(XX)	R81121T(XX)
Straight, Reducer	D11045	R81171T(XX)(XX)
45° Elbow		R81122T(XX)
45° Elbow, Reducer		R81172T(XX)(XX)
90° Elbow	D11034	R81123T(XX)
90° Elbow, Reducer		R81173T(XX)(XX)
Tee, Run Adapter	D11076-(XX)	R81124T(XX)
Tee, Run Adapter, Reducer		R81174T(XX)(XX)(XX)
Tee, Side Adapter	D11026-(XX)	R81126T(XX)
Tee, Side Adapter, Reducer	D11155A-(XX)(XX)(XX)	R81176T(XX)(XX)(XX)

Notes: 1. Permaswage fittings starting with “D” are rated only to 3,000 PSI and are not an equivalent to Rynglok® “R8” fittings.

Table 4. Permanent to Bulkhead Male Lipseal Fittings

Configuration	Permaswage P/N (Note 1)	Rynglok® P/N
Straight	D11019-(XX)	R81141T(XX)
Straight, Reducer		R81191T(XX)(XX)
45° Elbow	D11070-(XX)	R81142T(XX)
45° Elbow, Reducer		R81192T(XX)(XX)
90° Elbow	D11054A-(XX)	R81143T(XX)
90° Elbow, Reducer		R81193T(XX)(XX)
Tee, Run Adapter	D11076-(XX)	R81144T(XX)
Tee, Run Adapter, Reducer	D11077-(XX)(XX)(XX)	R81194T(XX)(XX)(XX)
Tee, Side Adapter	D11082-(XX)	R81146T(XX)
Tee, Side Adapter, Reducer		R81196T(XX)(XX)(XX)

Notes: 1. Permaswage fittings starting with “D” are rated only to 3,000 PSI and are not an equivalent to Rynglok® “R8” fittings.

Table 5. Permanent to Flareless Swivel Nut Fittings

Configuration	Permaswage P/N (Note 1)	Rynglok® P/N
Straight	D10007-(XX)+NUT	R82101T(XX)
	D10059-(XX)+NUT	R82101T(XX)
Straight, Reducer	D10177-(XX)(XX)	R82151T(XX)(XX)
45° Elbow	D10137-(XX)	R82102T(XX)
45° Elbow, Reducer	D10416-(XX) (XX)	R82152T(XX)(XX)
90° Elbow	D10021A-(XX)	R82103T(XX)
90° Elbow, Reducer	D10186-(XX)(XX)	R82153T(XX)(XX)
Tee, Run Adapter	D10178-(XX)	R82104T(XX)
Tee, Run Adapter, Reducer	D10272-(XX)(XX)(XX)	R82154T(XX)(XX)(XX)
Tee, Side Adapter	D10176-(XX)	R82106T(XX)
Tee, Side Adapter, Reducer	D10240-(XX)(XX)(XX)	R82156T(XX)(XX)(XX)
Notes: 1. Permaswage fittings starting with “D” are rated only to 3,000 PSI and are not an equivalent to Rynglok® “R8” fittings.		

Table 6. Permanent to Flareless Male Fittings

Configuration	Permaswage P/N (Note 1)	Rynglok® P/N
Straight	D10008-(XX)	R82121T(XX)
Straight, Reducer	D10057-(XX)(XX)	R82171T(XX)(XX)
45° Elbow		R82122T(XX)
45° Elbow, Reducer		R82172T(XX)(XX)
90° Elbow	D10034-(XX)	R82123T(XX)
90° Elbow, Reducer	D10066(XX)(XX)	R82173T(XX)(XX)
Tee, Run Adapter	D10099-(XX)	R82124T(XX)
Tee, Run Adapter, Reducer	D10099-(XX)(XX)(XX)	R82174T(XX)(XX)(XX)
Tee, Side Adapter	D10026-(XX)	R82126T(XX)
Tee, Side Adapter, Reducer	D10055-(XX)(XX)(XX)	R82176T(XX)(XX)(XX)
Notes: 1. Permaswage fittings starting with “D” are rated only to 3,000 PSI and are not an equivalent to Rynglok® “R8” fittings.		

Table 7. Permanent to Bulkhead Flareless Male Fittings

Configuration	Permaswage P/N (Note 1)	Rynglok® P/N
Straight	D10019-(XX)	R82141T(XX)
Straight, Reducer	D10041-(XX)(XX)	R82191T(XX)(XX)
45° Elbow	D10070-(XX)	R82142T(XX)
45° Elbow, Reducer	D10070-(XX)(XX)	R82192T(XX)(XX)
90° Elbow	D10054-(XX)	R82143(XX)
90° Elbow, Reducer	D10068-(XX)(XX)	R82193T(XX)(XX)
Tee, Run Adapter	D10076-(XX)	R82144T(XX)
Tee, Run Adapter, Reducer	D10076-(XX)(XX)(XX)	R82194T(XX)(XX)(XX)
Tee, Side Adapter	D10082-(XX)	R82146T(XX)
Tee, Side Adapter, Reducer	D10082-(XX)(XX)(XX)	R82196T(XX)(XX)(XX)
Notes: 1. Permaswage fittings starting with “D” are rated only to 3,000 PSI and are not an equivalent to Rynglok® “R8” fittings.		

Table 8. Permanent to Flared Swivel Fittings

Configuration	Permaswage P/N (Note 1)	Rynglok® P/N
Straight	D10010-(XX)+NUT	R83101T(XX)
Straight, Reducer		R83151T(XX)(XX)
45° Elbow	D10061-(XX)	R83102T(XX)
45° Elbow, Reducer		R83152T(XX)(XX)
90° Elbow	D10027A-(XX)	R83103T(XX)
90° Elbow, Reducer	D10110-(XX)(XX)	R83153T(XX)(XX)
Tee, Run Adapter	D10102-(XX)	R83104T(XX)
Tee, Run Adapter, Reducer	D10108-(XX)(XX)	R83154T(XX)(XX)(XX)
Tee, Side Adapter		R83106T(XX)
Tee, Side Adapter, Reducer	D10421-(XX)(XX)(XX)	R83156T(XX)(XX)(XX)
Notes: 1. Permaswage fittings starting with “D” are rated only to 3,000 PSI and are not an equivalent to Rynglok® “R8” fittings.		

Table 9. Permanent to Flared Male Fittings

Configuration	Permaswage P/N (Note 1)	Rynglok® P/N
Straight	D10011-(XX)	R83121T(XX)
Straight, Reducer		R83171T(XX)(XX)
45° Elbow		R83122T(XX)
45° Elbow, Reducer		R83172T(XX)(XX)
90° Elbow	D10064-(XX)	R83123T(XX)
90° Elbow, Reducer	D10065-(XX)(XX)	R83173T(XX)(XX)
Tee, Run Adapter	D10155-(XX)	R83124T(XX)
Tee, Run Adapter, Reducer	D10106-(XX)(XX)	R83174T(XX)(XX)(XX)
Tee, Side Adapter	D10073-(XX)	R83126T(XX)
Tee, Side Adapter, Reducer	D10074-(XX)(XX)	R83176T(XX)(XX)(XX)

Notes: 1. Permaswage fittings starting with “D” are rated only to 3,000 PSI and are not an equivalent to Rynglok® “R8” fittings.

Table 10. Permanent to Bulkhead Flared Fittings

Configuration	Permaswage P/N (Note 1)	Rynglok® P/N
Straight	D10046-(XX)	R83141T(XX)
Straight, Reducer	D10063-(XX)	R83191T(XX)(XX)
45° Elbow	D10069-(XX)	R83142T(XX)
45° Elbow, Reducer	D10071-(XX)(XX)	R83192T(XX)(XX)
90° Elbow	D10053-(XX)	R83143T(XX)
90° Elbow, Reducer	D10067-(XX)(XX)	R83193T(XX)(XX)
Tee, Run Adapter	D10075-(XX)	R83144T(XX)
Tee, Run Adapter, Reducer	D10077-(XX)(XX)	R83194T(XX)(XX)(XX)
Tee, Side Adapter	D10079-(XX)	R83146T(XX)
Tee, Side Adapter, Reducer	D10081-(XX)(XX)(XX)	R83196T(XX)(XX)(XX)

Notes: 1. Permaswage fittings starting with “D” are rated only to 3,000 PSI and are not an equivalent to Rynglok® “R8” fittings.

Table 11. Bulk Hose and Tube

Old Cancelled Specification	New Replacement Specification
MIL-H-6000	MIL-DTL-6000
MIL-T-6845	AMS-T-6845
MIL-T-8506	AMS-T-8506
WW-T-787	WW-T-700/4
WW-T-789	WW-T-700/6
MIL-T-6737	AMS 5575
	AMS 5576
MIL-T-7081	AMS-T-7081

Table 12. Fittings

Old Cancelled Specification	New Replacement Specification
MS21922	AS21922
MS21921	AS21921
MS20819	AS5176
MS87024	MIL-F-83798/7
MS87025	MIL-F-83798/8
MS87026	MIL-F-83798/9
MS24391	AS5169
MIL-F-18280	AS18280
MIL-F-5509	AS4841
	AS4842
	AS4842/1
	AS4842/2
	AS4843
	AS4843/1
	AS4843/2
	AS4875
	AS4875/1
	AS4875/2

Table 13. Hose and Tube Assemblies

Old Cancelled Specification	New Replacement Specification
MS27363	AS153
	AS627
MS27364	AS154
	AS628
MS27365	AS155
	AS629
MS27366	AS156
	AS630
MS27367	AS157
	AS631
MS27369	AS115
	AS622
MS27370	AS116
	AS623
MS27371	AS117
	AS623
MS27372	AS118
	AS624
MS27373	AS119
	AS625
MS27374	AS120
	AS626
MS27363	AS153
	AS627
MS27364	AS154
	AS628
MS23765	AS155
	AS629
MS23766	AS156
	AS630
MS23767	AS157
	AS631

Table 14. Caps and Plugs

Old Cancelled Specification	New Replacement Specification
MS21914	AS21914
AN806	AS5168
MS21913	AS21913
MS24404	AS5168
AN814	AS5169
MIL-C-5501	NAS847

Table 15. High Pressure Aluminum Caps (Blue in Color) Meets SAE-AS4841 Fitting Specification

Part Number (P/N)	Nomenclature	National Stock Number (NSNs)	Cap Thread Size	Tubing Size
AN929-D2	Cap, Threaded, 7075 Anodized Aluminum	4730-00-633-4398	5/16 Inch	1/8 Inch
AN929-D3	Cap, Threaded, 7075 Anodized Aluminum	4730-00-221-2126	3/8 Inch	3/16 Inch
AN929-D4	Cap, Threaded, 7075 Anodized Aluminum	4730-00-278-5006	7/16 Inch	1/4 Inch
AN929-D5	Cap, Threaded, 7075 Anodized Aluminum	4730-01-061-4150	1/2 Inch	5/16 Inch
AN929-D6	Cap, Threaded, 7075 Anodized Aluminum	4730-00-585-8769	9/16 Inch	3/8 Inch
AN929-D8	Cap, Threaded, 7075 Anodized Aluminum	4730-00-541-8296	3/4 Inch	1/2 Inch
AN929-D10	Cap, Threaded, 7075 Anodized Aluminum	4730-00-221-2127	7/8 Inch	5/8 Inch
AN929-D12	Cap, Threaded, 7075 Anodized Aluminum	4730-00-221-2128	1-1/16 Inches	3/4 Inch
AN929-D16	Cap, Threaded, 7075 Anodized Aluminum	4730-00-221-2129	1-3/8 Inches	1 Inch
AN929-D20	Cap, Threaded, 7075 Anodized Aluminum	4730-00-221-2130	1-5/8 Inches	1-1/4 Inches
AN929-D24	Cap, Threaded, 7075 Anodized Aluminum	4730-00-826-6462	1-7/8 Inches	1-1/2 Inches
AN929-D28	Cap, Threaded, 7075 Anodized Aluminum	4730-00-221-2116	2-1/4 Inches	1-3/4 Inches
AN929-D32	Cap, Threaded, 7075 Anodized Aluminum	4730-00-221-2117	2-1/2 Inches	2 Inches

Table 16. High Pressure Aluminum Plugs (Blue in Color) Meets SAE-AS4841 Fitting Specification

Part Number (P/N)	Nomenclature	National Stock Number (NSNs)	Cap Thread Size	Tubing Size
AS5168D02	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0109	5/16 Inch	1/8 Inch
AS5168D03	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0100	3/8 Inch	3/16 Inch
AS5168D04	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0110	7/16 Inch	1/4 Inch
AS5168D05	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0111	1/2 Inch	5/16 Inch
AS5168D06	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0112	9/16 Inch	3/8 Inch
AS5168D08	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0113	3/4 Inch	1/2 Inch
AS5168D10	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0116	7/8 Inch	5/8 Inch
AS5168D12	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0117	1-1/16 Inches	3/4 Inch
AS5168D16	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0118	1-3/8 Inches	1 Inch
AS5168D20	Plug, Threaded, 7075 Anodized Aluminum	4730-00-640-5104	1-5/8 Inches	1-1/4 Inches
AS5168D24	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0115	1-7/8 Inches	1-1/2 Inches
AS5168D28	Plug, Threaded, 7075 Anodized Aluminum	4730-00-640-0633	2-1/4 Inches	1-3/4 Inches
AS5168D30	Plug, Threaded, 7075 Anodized Aluminum	4730-00-287-0120	2-1/2 Inches	2 Inches

Table 17. Light Aluminum Caps for Storage and Shipping Meets NAS 817 Specification

Part Number (P/N)	Nomenclature	National Stock Number (NSNs)	Cap Thread Size	Tubing Size
NAS817-2	Cap, Threaded, 3003 Anodized Aluminum	5340-00-682-2112	5/16 Inch	1/8 Inch
NAS817-3	Cap, Threaded, 3003 Anodized Aluminum	5340-00-158-1313	3/8 Inch	3/16 Inch
NAS817-4	Cap, Threaded, 3003 Anodized Aluminum	5340-00-682-2113	7/16 Inch	1/4 Inch
NAS817-5	Cap, Threaded, 3003 Anodized Aluminum	5340-00-682-2114	1/2 Inch	5/16 Inch
NAS817-6	Cap, Threaded, 3003 Anodized Aluminum	5340-00-682-2115	9/16 Inch	3/8 Inch
NAS817-8	Cap, Threaded, 3003 Anodized Aluminum	5340-00-682-2116	3/4 Inch	1/2 Inch
NAS817-10	Cap, Threaded, 3003 Anodized Aluminum	5340-00-682-2117	7/8 Inch	5/8 Inch
NAS817-12	Cap, Threaded, 3003 Anodized Aluminum	5340-00-682-2118	1-1/16 Inches	3/4 Inch
NAS817-16	Cap, Threaded, 3003 Anodized Aluminum	5340-00-682-2119	1-3/8 Inches	1 Inch
NAS817-20	Cap, Threaded, 3003 Anodized Aluminum	5340-00-804-0788	1-5/8 Inches	1-1/4 Inches
NAS817-24	Cap, Threaded, 3003 Anodized Aluminum	5340-01-004-0107	1-7/8 Inches	1-1/2 Inches

Table 18. Light Aluminum Plugs for Storage and Shipping Meets NAS 818 Specification

Part Number (P/N)	Nomenclature	National Stock Number (NSNs)	Cap Thread Size	Tubing Size
M5501/1-2	Plug, Threaded, 3003 Anodized Aluminum	5340-00-804-1229	5/16 Inch	1/8 Inch
M5501/1-3	Plug, Threaded, 3003 Anodized Aluminum	5340-00-804-1224	3/8 Inch	3/16 Inch
M5501/1-4	Plug, Threaded, 3003 Anodized Aluminum	5340-00-433-3253	7/16 Inch	1/4 Inch
M5501/1-5	Plug, Threaded, 3003 Anodized Aluminum	5340-00-804-1228	1/2 Inch	5/16 Inch
M5501/1-6	Plug, Threaded, 3003 Anodized Aluminum	5340-00-292-3292	9/16 Inch	3/8 Inch
M5501/1-8	Plug, Threaded, 3003 Anodized Aluminum	5340-00-828-8802	3/4 Inch	1/2 Inch
M5501/1-10	Plug, Threaded, 3003 Anodized Aluminum	5340-00-804-1230	7/8 Inch	5/8 Inch
M5501/1-12	Plug, Threaded, 3003 Anodized Aluminum	5340-01-186-6879	1-1/16 Inches	3/4 Inch
M5501/1-16	Plug, Threaded, 3003 Anodized Aluminum	5340-00-804-1245	1-3/8 Inches	1 Inch
M5501/1-20	Plug, Threaded, 3003 Anodized Aluminum	5340-00-804-1248	1-5/8 Inches	1-1/4 Inches
M5501/1-24	Plug, Threaded, 3003 Anodized Aluminum	5340-01-217-1791	1-7/8 Inches	1-1/2 Inches
M5501/1-32	Plug, Threaded, 3003 Anodized Aluminum	5340-00-804-1254	2-1/2 Inches	2 Inches

Table 19. High Pressure Carbon Steel Caps

Part Number (P/N)	Nomenclature	National Stock Number (NSNs)	Cap Thread Size	Tubing Size
AS21914-2	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-01-068-3245	5/16 Inch	1/8 Inch
AS21914-3	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-289-8633	3/8 Inch	3/16 Inch
AS21914-4	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-640-0632	7/16 Inch	1/4 Inch
AS21914-5	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-618-9069	1/2 Inch	5/16 Inch
AS21914-6	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-618-3572	9/16 Inch	3/8 Inch
AS21914-8	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-289-8634	3/4 Inch	1/2 Inch
AS21914-10	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-618-4227	7/8 Inch	5/8 Inch
AS21914-12	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-202-8792	1-1/16 Inches	3/4 Inch
AS21914-16	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-274-7120	1-3/8 Inches	1 Inch
AS21914-20	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-554-8917	1-5/8 Inches	1-1/4 Inches
AS21914-24	Cap, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-834-4358	1-7/8 Inches	1-1/2 Inches

Table 20. High Pressure Carbon Steel Plugs

Part Number (P/N)	Nomenclature	National Stock Number (NSNs)	Cap Thread Size	Tubing Size
AS21913-2	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-01-068-3245	5/16 Inch	1/8 Inch
AS21913-3	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-289-8632	3/8 Inch	3/16 Inch
AS21913-4	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-595-2612	7/16 Inch	1/4 Inch
AS21913-5	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-541-1465	1/2 Inch	5/16 Inch
AS21913-6	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-203-3709	9/16 Inch	3/8 Inch
AS21913-8	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-202-8341	3/4 Inch	1/2 Inch
AS21913-10	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-966-5695	7/8 Inch	5/8 Inch
AS21913-12	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-289-8627	1-1/16 Inches	3/4 Inch
AS21913-16	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-289-8626	1-3/8 Inches	1 Inch
AS21913-20	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-00-289-8625	1-5/8 Inches	1-1/4 Inches
AS21913-24	Plug, Threaded, Steel Tube Fitting, Cadmium Plated w/ Supplementary Chromate Treatment	4730-01-067-3944	1-7/8 Inches	1-1/2 Inches

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

INTRODUCTION

AVIATION HOSE AND TUBE MANUAL

1. PURPOSE.

2. This manual provides aircraft maintenance personnel with information on hose and tube assemblies for military aircraft and aircraft equipment.

NOTE

Paragraphs noted **(NAVY ONLY)** or **(N)** apply to Naval aircraft systems only. Paragraphs noted **(AIR FORCE ONLY)** or **(AF)** are for Air Force Aircraft systems only. Unless noted, instructions apply to both Navy and Air Force.

a. **(NAVY ONLY)** When a conflict exists, applicable maintenance instruction manuals and FST engineering directives take precedence. If the MIM or FST directive fails to embody the direction of this manual, contact the applicable FST immediately.

b. **(AIR FORCE ONLY)** The instructions in this manual are general and are applicable except when otherwise specified in the manuals for the specific aerospace vehicle. If there is a conflict between this manual and the manuals for a particular aerospace vehicle, subsequent technical orders, technical notes, or change orders, the latter will govern in all cases.

3. SCOPE.

4. This manual provides the latest NAVAIR / AFMC approved methods and specifications to maintain, fabricate, repair, test, clean, inspect, identify and store hose and tube assemblies as replacement items in aircraft and aircraft equipment. This manual incorporates the technical information from Air Force T.O. 1-1A-8 chapter 13 and all of Air Force T.O. 42E1-1-1. This manual is divided into work packages (WPs) and subordinate work packages (SWPs) which are self-contained. Normally, a change results in a reissue of a specific WP. The WPs are numbered with five-digit numbers in the upper right corner of each page. This number aids in rapid assembly of a complete manual, and is used for referencing within the manual. Work Packages specific to a service are identified as such.

5. APPLICATION.

6. Information in this manual is divided into several major categories. WP003 00 through WP006 00 provide information on flexible hose and hose assemblies. WP 007 00 provides information on hydraulic system protective closures. WP008 00 through WP017 00 provide information on tube and tube assemblies. WP 018 00 provides information on high volume air delivery ducts.

a. **(NAVY ONLY)** These sections do not apply to Navy liquid oxygen tubing assemblies, but do apply to ambient temperature gaseous systems. Maintenance of liquid oxygen assemblies can be found in manuals or directives peculiar to the weapons system involved. Refer to type aircraft cognizant field activity for liquid oxygen system tubing manufacture. Work Package 007 00 applies to Naval Aircraft systems only.

b. **(AIR FORCE ONLY)** Maintenance of Air Force liquid oxygen tubing assemblies are found in Work Package 009 01. Work Packages 004 01, 009 01, and 010 01 apply to Air Force Aircraft systems only.

7. REQUISITION AND AUTOMATIC DISTRIBUTION OF TECHNICAL MANUALS.

8. Procedures to be used by Naval activities and other Department of Defense activities requiring NAVAIR technical manuals are defined in NAVAIR 00-25-100 and NAVAIRINST 5605.5 Series.

9. To automatically receive future changes and revisions to NAVAIR technical manuals, an activity must be established on the Automatic Distribution Requirements List (ADRL) maintained by the Naval Air Technical Data and Engineering Service Command (NATEC). To become established on the ADRL, notify your activity central technical publications librarian. If your activity does not have a library, you may establish your automatic distribution by contacting the

Commanding Officer, NATEC, Attn: Distribution, NAS North Island, Bldg. 90, P.O. Box 357031, San Diego, CA 92135-7031. Annual reconfirmation of these requirements is necessary to remain on automatic distribution. Please use your NATEC assigned account number whenever referring to automatic distribution requirements.

10. If additional or replacement copies of this manual are required with no attendant changes in the ADRL, they may be ordered by submitting a MILSTRIP requisition in accordance with NAVSUP 485 to Routing Identifier Code “NFZ”. MILSTRIP requisitions can be submitted through your supply office, Navy message, or SALTS to DAAS (Defense Automated Address System), or through the DAAS or NAVSUP web sites. For assistance with a MILSTRIP requisition, contact the Naval Inventory Control Point (NAVICP) Publications and Forms Customer Service at DSN 442-2626 or (215) 697-2626, Monday through Friday, 0700 to 1600 Eastern Time.

11. MANUAL ISSUE DATE.

12. The date on the title page is the copy freeze date. No additions, deletions, or changes are made after the manual issue date except last minute safety of flight or required maintenance changes. Data collected after the manual issue date will be included in later changes or revisions of the manual.

13. EFFECTIVITIES.

14. Effectivity notes on manual title pages, work package title pages, and within a work package indicate the equipment model to which the data applies. If no effectivity note appears on the work package title page, the work package has the same effectivity as shown on the manual title page. Paragraphs noted **(NAVY ONLY)** or **(N)** apply to Naval aircraft systems only. Para-graphs noted **(AIR FORCE ONLY)** or **(AF)** are for Air Force Aircraft systems only. Unless noted, instructions apply to both Navy and Air Force.

16. QUALITY ASSURANCE PROCEDURES.

17. Quality Assurance procedures are found in WP006 00. Quality Assurance paragraphs are noted with **(QA)**.

18. SAFETY SUMMARY.

19. The following general safety precautions are not related to any specific procedure and therefore do not appear elsewhere in this publication. These are precautions that personnel must understand and apply during all phases of operation and maintenance.

20. KEEP AWAY FROM LIVE CIRCUITS. Operating personnel must observe safety precautions at all times. Do not replace components or make adjustments inside any equipment with the high voltage supply turned on. Under certain conditions, dangerous potentials may exist when the power control is in the off position, due to charges retained by capacitors. To avoid casualties, always remove power, discharge, and ground a circuit before touching it.

21. DO NOT SERVICE OR ADJUST ALONE. Under no circumstances shall any person reach into or enter an enclosure for the purpose of servicing or adjusting the equipment, except in the presence of someone who is capable of rendering aid.

22. RESUSCITATION. Personnel working with or near high voltages should be familiar with modern methods of resuscitation. Such information may be obtained from the Bureau of Medicine and Surgery.

23. ENGINE NOISE. Personnel must observe the following precautions when working within danger areas of jet engines. Wear the proper protection (earplugs and/or earmuffs).

a. Do not exceed the time limits of exposure to various sound intensities.

b. Have periodic checks on hearing ability. The wearing of regulation earplugs or earmuffs will raise the time limits of exposure. All personnel working within danger areas should be familiar with calculated sound levels (as specified in the general information section of applicable Maintenance Instruction Manual) and should wear the necessary protection equipment.

24. FLIGHT LINE SAFETY PRECAUTIONS. Personnel working in or around aircraft on the flight line shall observe flight line safety precautions and regulations.

25. USE SAFETY SHIELDS. Personnel shall observe applicable safety regulations and use safety shields on power tools where provided. Adequate shielding to protect eyes and face shall be used at all times when operating power tools or performing pressure tests.

26. HANDLING FLUIDS AND GASES. Be very careful when troubleshooting hydraulic systems under pressure to avoid accidental injection of fluid under

the skin. Fluid injection can result in serious injury and great pain. Get immediate medical attention. Do not stand in direct line with drawbolt assembly. If wrong swage pressure is accidentally applied, a drawbolt failure is possible (WP015 00). Observe applicable safety precautions when using fluids or gases which are flammable or toxic. Do not use gases or fluids which are not positively identified.

27. SEAT EJECTION MECHANISMS. Safety precautions shall be strictly observed when working around aircraft equipped with an ejection seat. These safety precautions cannot be overemphasized. Each ejection seat has several ground safety pins. These safety pins are provided on red-flagged lanyards for use at every point of potential danger. They shall be installed whenever the aircraft is on the ground or deck, and must never be removed until the aircraft is ready for flight.

28. The following general precautions should always be kept in mind:

a. Ejection seats shall be treated with the same respect as a loaded gun.

b. Always consider an ejection seat system as loaded and armed.

c. Before entering a cockpit, know where the ejection seat safety pins are and be certain of their installation.

d. Only authorized personnel may work on or remove/install ejection seats and components and only in authorized area.

29. REFERENCE MATERIAL.

30. Table 1 lists the specifications and standards referred to in this manual. In many instances, procedures called out in this manual can best be performed in conjunction with other system or component manuals and directives also listed in Table 1.

31. SUPPORT EQUIPMENT REQUIRED.

32. The procedures specified in this manual require tools that are in common fleet usage at the Organization level; methods requiring production equipment or tools normally used by manufacturers or Depot level industrial plants are not included, unless otherwise noted. All support equipment for the maintenance of the aviation hoses and tubes is listed in Table 2. When an item of support equipment is not available, an approved alternate identified in the activity's Individual Material Readiness List may be substituted.

33. MATERIALS REQUIRED.

34. All materials required for the maintenance of the aviation hoses and tubes are listed in Table 3.

35. TECHNICAL DIRECTIVES.

36. Refer to Table 4 for a historical record of applicable technical directives. A record of current applicable technical directives will also appear on the title page of each WP in this manual, but will list only those technical directives that affect the text and illustrations of that particular WP.

37. ABBREVIATIONS.

38. Abbreviations used in this manual are listed in Table 5.

39. GLOSSARY.

40. A glossary of terms used in this manual is found in Table 6.

Table 1. Reference Material

Specification/Standard	Title
AN6270	Hose Assembly - Detachable Swivel Fitting, Low Pressure
AN929	Cap Assembly, Pressure Seal Flared Tube Fitting
BB-O-925	Oxygen
DTD-5016	British Annealed Stainless Tubing
H4-1	Commercial and Governement Entity (CAGE) Catalog Handbook, Name to Code
H4-2	Commercial and Governement Entity (CAGE) Catalog Handbook, Code to Name
MIL-A-46146, Type II	Adhesives - Sealants, Silicone, RTV, Non-corrosive
MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-C-5056	Coating, Permanent Resin, Process for Application to Aircraft Parts
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-C-81302	Trichlorotrifluoroethane (freon)
MIL-C-85052	Clamp, Loop, Cushion, General Specification for
MIL-D-16791	Detergent, General Purpose, Liquid Nonionic
MIL-D-19326	Design and Installation of Liquid Oxygen Systems in Aircraft, General Specification for
MIL-DLT-6000	Hose, Rubber, (Fuel, Oil, Coolant, Water and Alcohol)
MIL-F-27272	Fittings, Tetrafluoroethylene Hose, High Temperature, Medium Pressure, General Specification for
MIL-F-83296	Fittings, Tetrafluoroethylene Hose, High Temperature, High Pressure (3000 psi), Hydraulic and Pneumatic
MIL-DTL-25579 (MIL-H-25579)	Hose Assembly, Tetrafluoroethylene, High-Temperature, Medium-Pressure
MIL-DTL-27267 (MIL-H-27267)	Hose, Tetrafluoroethylene, High Temperature, Medium Pressure
MIL-DTL-5593 (MIL-H-5593)	Hose, Aircraft, Low-Pressure, Flexible

Table 1. Reference Material (Cont)

Specification/Standard	Title
MIL-PRF-5606 (MIL-H-5606)	Hydraulic Fluid, Petroleum Based, Aircraft; Missile and Ordnance
MIL-H-775	Hose, Hose Assemblies; Rubber, Plastic, Fabric or Metal (including tubing) and Associated Hardware
MIL-H-81019	Hydraulic Fluid, Petroleum Based, Ultra Low Temperature
MIL-DTL-83298 (MIL-H-83298)	Hose, Tetrafluoroethylene, High-Temperature, High-Pressure (3000 psi) Hydraulic and Pneumatic
MIL-DTL-83796 (MIL-H-83796)	Hose Assembly, Rubber, Lightweight, Medium-Pressure, General Specification for
MIL-DTL-83797 (MIL-H-83797)	Hose, Rubber, Lightweight, Medium-Pressure, General Specification for
MIL-DTL-8788 (MIL-H-8788)	Hose, Hydraulic, High-Pressure
MIL-DTL-8790 (MIL-H-8790)	Hose Assemblies, Rubber, Hydraulic, High-Pressure (3000 psi)
MIL-DTL-8794 (MIL-H-8794)	Hose, Rubber, Hydraulic, Fuel and Oil-Resistant
MIL-DTL-8795 (MIL-H-8795)	Hose Assemblies, Rubber, Hydraulic, Fuel- and Oil-Resistant
MIL-P-38477	Plastic Material, Pressure Sensitive Adhesive, for Aerospace Identification and Marking
MIL-PRF-16173	Corrosion Preventive Compound, Solvent Cutback, Cold Application
MIL-PRF-23377	Primer Coatings, Epoxy, High-solids
MIL-PRF-23699	Lubricating Oil, Aircraft Turbine Engines, Synthetic Base, NATO Code 0-156
MIL-PRF-3043	Resin Coating, Permanent, for Engine Compartments and Metal Parts
MIL-PRF-32033	Lubricating Oil, General Purpose, Preservative (Water-Displacing, Low Temperature)
MIL-PRF-46846	Rubber, Synthetic, Heat-shrinkable
MIL-PRF-6085	Lubricating Oil, Instrument, Aircraft, Low, Volatility

Table 1. Reference Material (Cont)

Specification/Standard	Title
MIL-PRF-83282	Hydraulic Fluid, Fire-Resistant, Synthetic Hydrocarbon Base, Aircraft, Metric, NATO Code H-537
MIL-PRF-85570, Type II	Cleaning Compound, Aircraft Exterior
MIL-PRF-85582	Primer Coatings, Epoxy, Waterborne
MIL-S-45180	Sealing Compound, Gasket, Hydrocarbon Fluid and Water Resistant
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series: General Specification for
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for
MIL-STD-129	Standard Practice for Military Marking
MIL-STD-33610	TBD
MIL-STD-7179	Finishes, Coatings and Sealants, Protection of Aerospace Weapons Systems
MIL-T-5695	Tubing, Steel, Corrosion Resistant (304), Cold Drawn
MIL-T-81772	Thinner, Aircraft Coating
MIL-T-8504	Tubing, Steel, Corrosion Resistant (304), Aerospace Vehicle Hydraulic Systems, Annealed Seamless and Welded
MIL-T-8606	Tubing, Steel, Corrosion Resistant (18-8 Stabilized and Extra Low Carbon)
MIL-T-8808	Tubing, Steel, Corrosion Resistant (18-8 Stabilized), Aircraft Hydraulic Quality
MIL-T-8973	Tubing, Steel, Corrosion and Heat Resistant, For Aerospace Vehicle and Hydraulic Systems Assembled by Brazing
MMM-A-1617	Adhesive, Rubber Base, General Purpose
MS9015	Plug, Machine Thread - “O” Ring Seal
MS9404	Plug, Machine Thread - AMS 5646, Preformed Packing
NAS 817	Cap, Protective, Flared Fitting
NAS 818	Plug, Protective, Flared Tube, Hose Assembly or MS33649 Boss

Table 1. Reference Material (Cont)

Specification/Standard	Title
NAS 847	Cap and Plug, Protective, Dust and Moisture Seal
NAVAIR 01-1A-17	Aviation Hydraulics Manual, Organizational, Intermediate and Depot
NAVAIR 01-1A-509	Aircraft Weapons Systems Cleaning and Corrosion Control, Organizational and Intermediate
NAVAIR 06-30-501	Technical Manual of Oxygen/Nitrogen Cryogenic Systems
NAVAIR 13-1-6.4	Aviation Crew Systems Oxygen Equipment
NAVAIR 13-30-41	Seats, Rocket Assisted Ejection Pilot Bombardier/Navigator and EMCO 1, 2, and 3 Depot Instruction Manual
NAVAIR 17-10DA-5	Maintenance Instruction Manual (MIM) with Illustrated Parts Breakdown (IPB) for Permaswage Repair Kit D10040
NAVSEA Report on:	Aqueous Oxygen Cleaning Products and Processes DTD 24 March 1994
OPNAVINST 4790.2	Naval Aviation Maintenance Program
SAE A-A-58092	Tape, Antiseize, Polytetrafluoroethylene, with Dispenser
SAE A-A-59503	Nitrogen, Technical
SAE AMS 4944	Titanium Alloy, Seamless, Hydraulic Tubing 3.0A1 - 2.5 V Cold Worked, Stress Relieved
SAE AMS 5516	Steel Sheet, Strip, and Plate, Corrosion Resistant 18CR-9.0NI (SAE 30302) Solution Heat Treated
SAE AMS 5517	Steel Sheet, Strip, and Plate, Corrosion Resistant 18CR-8NI (SAE 30301) Cold Rolled, 125 KSI Tensile Strength
SAE AMS 5518	Steel Sheet, Strip, and Plate, Corrosion Resistant 18CR-8NI (SAE 30301) Cold Rolled, 150 KSI Tensile Strength (UNS S30100)
SAE AMS 5519	Steel Sheet, Strip, and Plate, Corrosion Resistant 18CR-8NI (SAE 30301) Cold Rolled, 185 KSI Tensile Strength (UNS S30100)

Table 1. Reference Material (Cont)

Specification/Standard	Title
SAE AMS 5556	Steel, Corrosion and Heat Resistant, Seamless or Welded Hydraulic Tubing, 18CR-11NI 0.70(CB+TA) (SAE 30347) Solution Heat Treated (UNS S34700)
SAE AMS 5557	Steel Tubing, Seamless and Welded Hydraulic, Corrosion and Heat Resistant, 18.5CR-10.5NI-0.4TI (SAE 30321) Solution Heat Treated (UNS S32100)
SAE AMS 5560	Steel, Corrosion Resistant, Seamless Tubing 19CR-10NI (SAE 30304) Solution Heat Treated (UNS S30400)
SAE AMS 5561	Steel, Corrosion and Heat Resistant, Welded and Drawn or Seamless and Drawn Tubing 9.0Mn-20Cr-6.5NI-0.28N High-Pressure Hydraulic (UNS S21900)
SAE AMS 5563	Steel, Corrosion Resistant, Seamless and Welded Tubing 19CR-9.5NI (SAE 30304) Cold Drawn, Quarter Hard-Temper (UNS S30400)
SAE AMS 5564	Steel Sheet, Strip, and Plate, Corrosion Resistant 18CR-10NI (SAE 30304) High Pressure Hydraulic, Welded Plus Ultrasonically Tested or Seamless (UNS S30400)
SAE AMS 5565	Steel, Corrosion Resistant, Welded Tubing 19CR-9.5NI (SAE 30304) Solution Heat Treated (UNS S30400)
SAE AMS 5566	Steel, Corrosion Resistant, Seamless or Welded Hydraulic Tubing 19CR-10NI (SAE 303004) High Pressure Cold Drawn (UNS S30400)
SAE AMS 5567	Steel Tubing, Seamless or Welded, Corrosion Resistant 19CR-10NI (SAE 30304) Hydraulic, Annealed (UNS S30400)
SAE AMS 5569	Steel, Corrosion and Heat Resistant, Seamless and Welded Hydraulic Tubing 19CR-9.5NI-0.03C Max Cold Drawn, One Eighth Hard-Temper (UNS S30400)
SAE AMS 5575	Tubing, Steel, Corrosion and Heat Resisting (18-8 Stabilized, Welded)
SAE AMS 5576	Tubing, Steel, Corrosion and Heat Resisting (18-8 Stabilized, Welded)

Table 1. Reference Material (Cont)

Specification/Standard	Title
SAE AMS 5584	Steel, Corrosion and Heat Resistant, Seamless and Welded Hydraulic Tubing 17CR-12NI-1.5MO-0.03C Max Cold Drawn, One Eighth Hard-Temper (UNS S30400)
SAE AMS 5656	Steel, Corrosion Resistant, Bars, Wires, Forgings, Extrusions and Rings 9.0Mn-20CR-6.5Ni-0.27N Solution Heat Treated (UNS 21904)
SAE AMS 5897	Steel, Corrosion and Heat Resistant, Seamless or Welded Hydraulic Tubing 18.5CR-11NI-0.8CB (SAE 30347) Solution Heat Treated (UNS S34700)
SAE AMS 5901	Steel Sheet, Strip, and Plate, Corrosion Resistant 18CR-8NI(SAE 30301) Solution Heat Treated
SAE AMS 5902	Steel Sheet, Strip, and Plate, Corrosion Resistant 18CR-8NI(SAE 30301) Cold Rolled, 175 KSI Tensile Strength
SAE AMS 5903	Steel Sheet, Strip, and Plate, Corrosion Resistant 18CR-9.0NI(SAE 30302) Cold Rolled, 125 KSI Tensile Strength
SAE AMS 7081	Tube, Aluminum Alloy, Seamless, Round, Drawn, 6061 Aircraft Hydraulic Quality
SAE AMS DTL 23053/8	Insulation Sleeving, Electrical, Heat Shrinkable, Polyvinylidene Fluoride, Semi-Rigid, Crosslinked
SAE AMS-G-4343	Grease, Pneumatic System
SAE AMS-G-6032	Grease, Plug Valve, Gasoline and Oil-Resistant, NATO Code Number G-363, Metric
SAE AMS-S-8802	Sealing Compound, Temperature-resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion
SAE AMS-T-6845	Tubing, Steel, Corrosion-Resistant (S30400), Aerospace Vehicle Hydraulic System 1/8 Hard Condition
SAE AMS-T-8506	Tubing, Steel, Corrosion-Resistant, (304), Annealed, Seamless and Welded
SAE AN6270	Hose Assembly - Detachable Swivel Fitting, Low Pressure
SAE AS 1055	Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings, and Similar System Components

Table 1. Reference Material (Cont)

Specification/Standard	Title
SAE AS 1072	Sleeve, Hose Assembly, Fire Protection
SAE AS 1339	Hose Assembly, Polytetrafluoroethylene, 400 Degrees Fahrenheit, 3000 psi, Hydraulic and Pneumatic
SAE AS 13591	Cleaning Methods and Procedures for Breathing Oxygen Equipment
SAE AS 18280	Fitting, 24 Degrees Cone Flareless, Fluid Connection, 3000 psi
SAE AS 1933	Age Controls for Hose Containing Age-Sensitive Elastomeric Material
SAE AS 21913	Plug, Flareless Tube FSC 4730
SAE AS 21914	Cap, Pressure Seal, Flareless Tube Fitting FSC 4730
SAE AS 21921	Nut, Sleeve Coupling, Flareless FSC 4730
SAE AS 21922	Sleeve, Coupling, Flareless FSC 4730
SAE AS 33611	Tube Bend Radii
SAE AS 5168	Fitting, Plug, Tube End, Flared FSC 4730
SAE AS 5169	Fitting, Port Plug and Bleeder FSC 4730
SAE AS 5176	Fitting, Sleeve, Flared FSC 4730
SAE AS 5440	Hydraulic Systems, Aircraft, Requirements for Design and Installation
SAE AS 604	Hose Assembly, Polytetrafluoroethylene, 400 Degrees Fahrenheit, 3000 psi, Hydraulic, Heavy Weight
SAE AS 71051	Pipe Threads, Taper, Aeronautical National Form, Symbol Aeronautical National Taper Pipe Threads (ANPT) General Requirements for
SAE ASTM D329	Standard Specification for Acetone
SAE ASTM E1417	Inspection, Liquid Penetrant
TT-P-1757	Primer Coating, Zinc Chromate
WW-T-700	Tube, Aluminum Alloy, Drawn, Seamless, 5052, General Specification for
WW-T-700/1	Tube, Aluminum Alloy, Drawn, Seamless, 1100
WW-T-700/4	Tubing, Aluminum Alloy, Drawn, Seamless
WW-T-700/6	Tube, Aluminum Alloy, Drawn, Seamless, 6061

Table 2. Support Equipment Required

Part No. or Type Designation	Nomenclature
—	Air Heat Gun Rated 120°F - 1100°F and 1500 Watt or Equivalent
—	Band Clamp Tool
—	Bench Vise
—	Deburring Tools
—	Hand Flaring Tool
—	Hand Tube Bender or Mechanical Tube Bender
—	Mandrels
—	Marking Pencil
—	Masking or Plastic Electrical Tape
—	Oil Can
—	Open-End Wrench Sets
—	Pneumatic Flaring Machine
—	Protractor
—	Sharp Knife
—	Slip Joint Pliers
—	Small Paint Brush
—	Steel Ruler
—	Swaging Tool
—	Thickness Gage (Leaf Type)
—	Tube Cutter
—	Tube Flaring Tool (Double Flare)
—	Tube Flaring Tool (Single Flare)
D10145	Marking Tool
S1272-8-1	Socket Preseat Hand Tool

Table 3. Materials Required

Specification or Part Number	Nomenclature
A-A-58092	Antiseize Tape
A-A-59503	Nitrogen
AN815	Union
AN818	Nut
AN819	Sleeve
AS 1072	Firesleeve
MIL-C-81302	Trichlorotrifluoroethane
MIL-D-16791	Detergent
MIL-DTL-6000	Hose
MIL-F-27272	Fitting
MIL-F-83296	Fitting
MIL-DTL-25579	Hose
MIL-DTL-27267	Hose
MIL-DTL-5593	Hose
MIL-DTL-7938	Hose
MIL-H-81019	Hydraulic Fluid
MIL-DTL-83298	Hose
MIL-DTL-83797	Hose

Table 3. Materials Required (Cont)

Specification or Part Number	Nomenclature
MIL-DTL-8788	Hose
MIL-DTL-8794	Hose
MIL-PRF-16173, Class II, Grade 2	Corrosion Preventive Compound
MIL-PRF-23699	Oil, Lubricating
MIL-PRF-23377	Epoxy Polyamide Primer
MIL-PRF-46846, Type V	Tubing, Clear, Heat Shrinkable
MIL-PRF-83282	Hydraulic Fluid
MIL-PRF-85570, Type II	Aircraft Exterior Cleaning Compound
MIL-PRF-85582	Epoxy Primer
MIL-S-45180, Type II	Gasket Sealing Compound
MIL-S-46146, Type II	Adhesive
SAE AMS-DTL-23053/8	Tubing, Heat Shrinkable
SAE AMS-G-4343	Grease, Pneumatic System
SAE AMS-G-6032	Grease, Plug Valve
SAE AMS-S-8802	Sealant
1081	Clamp, Firesleeve
900591B	Clamp, Firesleeve

Table 4. Historical Record of Applicable Technical Directives

None

Table 5. Abbreviations

Abbreviation	Definition
AFMC	Air Force Material Command
ALC	Air Logistics Center
FST	Fleet Support Team
IMA	Intermediate Maintenance Activity
MIM	Maintenance Instruction Manual
MRC	Maintenance Requirement Cards
NADEP	Naval Aviation Depot
NAVAIR	Naval Air Systems Command
OMA	Organizational Maintenance Activity
PTFE	Polytetrafluoroethylene
SPO	System Program Office
T.O.	Technical Order

Table 6. Glossary

Term	Definition
Acceptance Life	The period of time from cure date to date of delivery to or acceptance by the procuring activity.
Age Control	The efforts made during manufacture, purchases, and storage of age-sensitive items and parts made from natural or synthetic materials to assure conformance to applicable material and performance specification.
Backup Ring	A device used to prevent pressure and friction from extruding the O-ring packing through the clearance gap of a seal.
Broaching	Broaching is the process in which serrations are cut into the counterbore wall of the port using one of the Rosan series tools.
Cognizant Engineering Activity	The Navy activity which has been assigned the responsibility and delegated the authority to perform specific engineering functions. Such responsibilities may be assumed by Naval Air System Command Headquarters (NAVAIR) or delegated to a Cognizant Field Activity (CFA).
Crimping	The forming of relatively small corrugations in order to set down and lock a seam to an arc in a strip of metal, or to reduce an existing arc or diameter.
Contaminant	Any material or substance which is undesired or capable of adversely affecting the hydraulic system or its components.
Cryofit Coupling	The cryofit coupling is a permanent tube and pipe joining product which uses the shape memory properties of a unique alloy of Titanium and Nickel.
Deburring Tool	A tool that is made to remove burrs from the inside diameter of cut tubing.
Depot Maintenance	That maintenance performed on material requiring major overhaul or a complete rebuild of parts, assemblies, subassemblies, and end items, including the manufacture of parts, modifications, testing, and reclamation as required. Depot maintenance serves to support lower levels of maintenance by providing technical assistance and performing that maintenance beyond the responsibility and capability of Organizational and Intermediate maintenance levels.
Dynatube Fittings	Consists of a threaded male connector, a female shoulder with a machined beam and a nut. They have solid film lubricant on all sliding surfaces which allows the fittings to be assembled without additional lubrication.

Table 6. Glossary (Cont)

Term	Definition
Free Air	Any compressible gas, air or vapor trapped within a hydraulic system that does not condense or dissolve to form a part of the system fluid.
Gasket	A type of seal which is formed by crushing the packing material into the gland such that the cavity formed by the gland is normally filled with the packing material.
Intermediate Maintenance Activity (IMA)	A Navy/USMC maintenance activity designated to provide direct maintenance support to using organizations. Its responsibilities normally consist of calibration, test, repair, or replacement of damaged or unserviceable parts, components, or assemblies; emergency manufacture of nonavailable parts; and technical assistance to using organizations.
Maintenance Instruction Manual (MIM)	A manual containing instructions for intermediate and organizational level servicing and maintenance of a specific model of aircraft or equipment.
Maintenance Requirement Cards (MRC)	Sets of cards issued by NAVAIR containing scheduled maintenance requirements applicable to intermediate and organizational level activities for the specific model of aircraft or SE for which they are issued.
Mandrel	Mandrels are special hand tools. They consist of a short piece of solid bar of any kind of material such as steel.
Manifold	An assembly which serves as a fluid conductor having multiple connection ports.
Naval Aviation Depot (NADEP)	A Navy activity tasked with and having the capability to provide depot level maintenance.
Naval Air Systems Command (NAVAIR)	The Navy headquarters activity having overall responsibility for the acquisition and support of aeronautical weapons systems and related material.
Navy Standard (Hydraulic Contamination)	A standard used to quantitatively grade levels of particulate contamination. The standard defines seven class levels of particles (0 thru 6) of contamination based on the quantity identified in 100 ml of fluid.
Organizational Maintenance Activity (OMA)	The maintenance capability provided by the using organization itself in support of its assigned equipment. Such maintenance normally includes inspection, servicing, lubrication, adjustment and replacement of parts, minor assemblies, and subassemblies.

Table 6. Glossary (Cont)

Term	Definition
Packing	The component of a seal which serves as a sealing medium by nature of its plastic or elastic properties, or its ability to deform into the shape of the gland.
Protective Closure	Metal closures approved for sealing hydraulic equipment.
PTFE	Polytetrafluoroethylene (teflon) tubing.
Purging	A decontamination process in which the aircraft system is drained to the maximum extent practical and the removed fluid discarded. A suitable cleaning agent is then introduced into the system and circulated as effectively as possible so as to remove gross contaminants. The operation is completed by removing the circulated cleaning agent and replacing it with new working fluid. Purging is usually followed by a period of recirculation cleaning to ensure adequate decontamination. System purging is limited to use by depot level maintenance activities.
Rosan Fittings	Rosan Fittings are designed to function as unions with one end connected to the port of a unit and the other end connected to the tube assemblies.
Seal	A device to retain fluid within a hydraulic component. The seal may consist of two or more components, such as a packing in a gland, and a packing and backup ring in a gland.
Service Life	The period of time from date of installation to date of removal.
Shelf Life	The period of time from date of acceptance or delivery by Organizational, Intermediate, or Depot level activity to date of use.
Squeeze	The dimension by which a packing is distorted from its molded shape when installed in a packing gland.
Support Equipment (SE), Hydraulic	Equipments intended for use in servicing and testing hydraulic system components. Includes portable hydraulic test stands, stationary hydraulic test stands, hydraulic check and fill stands, hydraulic fluid dispersing units and purifier.
Swage	(1) The operation of reducing or changing the cross-section area of stock by the fast impact of revolving dies. (2) The tapering of bar, rod, wire, or tubing by forging, hammering, or squeezing; reducing a section by progressively tapering lengthwise until the entire section attains the smaller dimensions of the taper.

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION

BULK HOSE AND HOSE FITTINGS

Reference Material

Hose Assembly, Fabrication WP004 00
Hose and Hose Assembly, Quality Assurance WP006 00
Commercial and Government Entity (CAGE) Catalog Handbook H4-1/H4-2
Naval Aviation Maintenance Program..... OPNAVINST 4790.2

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Record of Applicable Technical Directives

None

1. GENERAL.

2. This section describes the marking and identification of bulk hose and fittings for use in military aircraft.

3. HOSES.

4. There are two basic hose types used in military aircraft and related equipment: synthetic rubber and polytetrafluoroethylene (Teflon®). Synthetic rubber hoses are designed for specific fluid, temperature, and pressure ranges. Teflon® hoses are also designed for specific temperature and pressure ranges, but are not affected by fuel, lubricating oil, water-alcohol, and hydraulic or pneumatic systems or solvents commonly associated with aviation use. Although Teflon® is not affected by various fluids used in synthetic rubber hoses, the two types are not to be interchanged indiscriminately when replacing a hose.

5. HOSE DESCRIPTION AND APPLICATIONS. All hoses described in this manual (Table 1) consist of multiple layers of various materials, with each layer being concentric and uniform in accordance with the particular specification. Specifications and applications are outlined in Table 2.

6. HOSE IDENTIFICATION. Synthetic rubber hose is manufactured to military and industrial specifications according to the intended operating pressure and temperature range required for specific applications. All bulk hose with a rubber outer cover is identified by markings on the outer cover.

7. The lightweight, medium-pressure, synthetic rubber hose has a steel-braided outer cover and is identified by a band attached near each end. It has an additional band near the center of the hose if the bulk length is more than ten feet.

8. Bulk Hose Marking. Synthetic rubber hose, (if rubber covered) is identified by the indicator stripe and markings which are stenciled along the length of the hose. The indicator stripe, also called the lay line because of its use in determining the straightness or lie of a hose, is a series of dots or dashes. The markings (letters and numerals) contain the following information repeated at 9-inch intervals (Figure 1).

9. Dash and Number. The dash and number, in sixteenths (1/16) of an inch, refer to the equivalent outside diameter (OD) of rigid tube size in inches. The dash number does not denote the inside diameter (ID) or OD of the hose. A dash 8 (-8) mates to a number 8 rigid tube which has an outside diameter of 1/2 inch (8/16). The inside of the hose will not be 1/2 inch, but slightly smaller to allow for tube thickness.

10. Synthetic Rubber Hose Marking. Synthetic rubber hose, if wire braid covered, is identified by bands wrapped around hose ends and at intervals along the length of the hose. Each band is marked with the same information (Figure 1).

11. Teflon Hose Marking. polytetrafluoroethylene (Teflon®) hose is identified by metal or pliable plastic bands (Figure 1) at hose ends and at 3-foot intervals along the length of the hose.

12. Hose Shelf Life. Refer to WP 006, paragraph 17 for shelf life requirements of bulk hose and hose assemblies.

Table 1. Hose Specifications and Applications

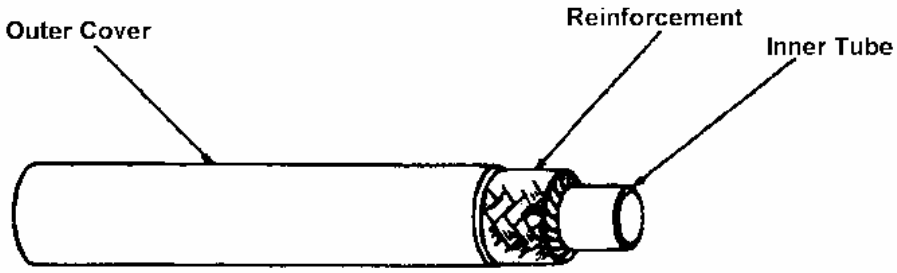
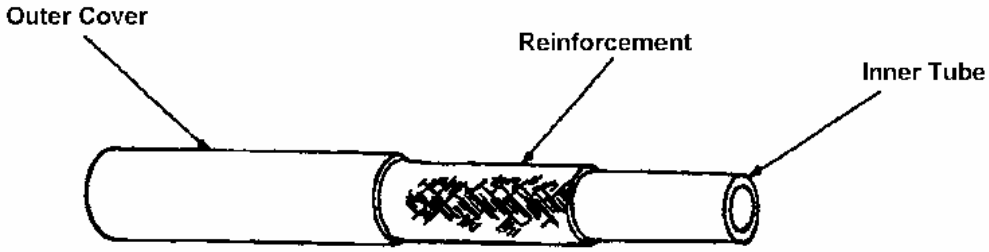
Low-Pressure Synthetic Rubber Hose MIL-DTL-5593					
 003t01a					
Construction Material			**Intended Use**	**Cautions**	**Use To Fabricate Hose Assy**
Inner Tube	**Reinforcement**	**Outer Cover**			
Synthetic rubber compound, seamless construction, resistant to: petroleum base fuel, lubricating oil, hydraulic fluid	Yarn-cotton	Abrasion-resistant compound, resistant to: fuel, oil	Low-pressure air and vacuum instrument systems, automatic pilots, and pressure gages	AN6270	
Low-Pressure Synthetic Rubber Hose MIL-DTL-6000					
 003t01b					
Construction Material			**Intended Use**	**Cautions**	**Use To Fabricate Hose Assy**
Inner Tube	**Reinforcement**	**Outer Cover**			
Synthetic rubber compound, seamless construction, resistant to: petroleum base fuel, lubricating oil, coolants, and water alcohol	One or more pliers of high tensile yarn	Polycloroprene (neoprene) rubber incorporated into outer ply of reinforcement	Low-pressure fuel, oil, coolant, water, and alcohol lines in engine installations	MIL-DTL-6000 has a tendency to collapse if used in lengths over 18 inches	None

Table 1. Hose Specifications and Applications (Cont)

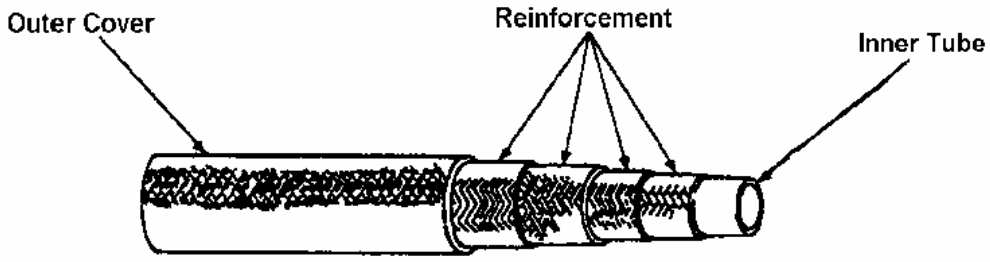
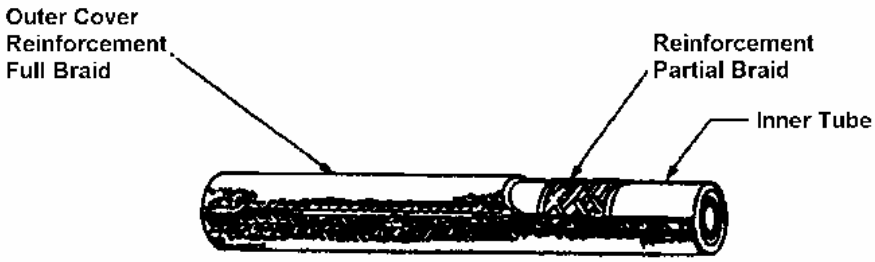
Medium-Pressure Synthetic Rubber Hose MIL-DTL-8794					
 003t01c					
Construction Material			**Intended Use**	**Cautions**	**Use To Fabricate Hose Assy**
Inner Tube	**Reinforcement**	**Outer Cover**			
Synthetic rubber compound, seamless construction, resistant to: petroleum base fuel, lubricating oil, hydraulic fluid	Inner cotton braid and wire braid	Synthetic rubber impregnated cotton braid, resistant to: oil (petroleum base)	Medium-pressure hydraulic, fuel, and petroleum base oil system applications		MIL-DTL-8795
Light Weight Medium-Pressure Synthetic Rubber Hose MIL-DTL-83797					
 003t01d					
Construction Material			**Intended Use**	**Cautions**	**Use To Fabricate Hose Assy**
Inner Tube	**Reinforcement**	**Outer Cover**			
Synthetic rubber compound, seamless construction, resistant to: petroleum base fuel, lubricating oil, hydraulic fluid	Partial inner braid, full outer of braids Corrosion-Resistant Steel (CRES) wire type 18-8	CRES wire type 18-8	Fuel, petroleum base lubricating oil, and hydraulic systems	Do not use for vacuum or hydraulic impulse systems	MIL-DTL-83796

Table 1. Hose Specifications and Applications (Cont)

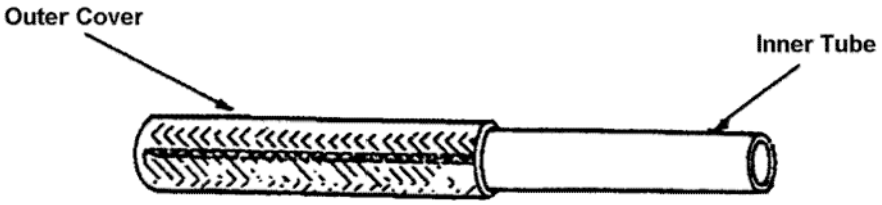
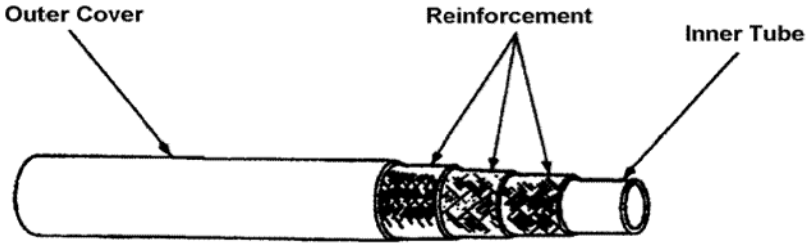
Medium-Pressure PTFE Hose MIL-DTL-27267					
 003t01e					
Construction Material			**Intended Use**	**Cautions**	**Use To Fabricate Hose Assy**
Inner Tube	**Reinforcement**	**Outer Cover**			
Virgin tetra-fluoroethylene resin	CRES wire braid	CRES wire braid type 18-8 hose under size -16 single layer. Hose size - 16Z and above, two layers of braid. The letter Z following a dash size indicates wire braid is mandatory.	High-temperature fuel, lubricating oil, water-alcohol, and hydraulic and pneumatic systems	Do not use MIL-DTL-25579-3/-4 hose assembly in aircraft hydraulic systems. This is a special fitting arrangement which has a swivel nut and cone seat of nipple which mates with an AS 4395 fitting. The remainder of the assembly mates with 2-4 size hose. Do not use in pneumatic storage systems. Maximum temperature is 450°F for fuel, lubricating oil, and water-alcohol systems. Maximum temperature is 400°F for hydraulic and pneumatic systems.	
High-Pressure Synthetic Rubber Hose MIL-DTL-8788					
 003t01f					
Construction Material			**Intended Use**	**Cautions**	**Use To Fabricate Hose Assy**
Inner Tube	**Reinforcement**	**Outer Cover**			
Synthetic rubber compound, seamless construction, resistant to oil (petroleum base)	CRES wire braids	Chloroprene polymer compound	Hydraulic or gaseous systems not exceeding 3000 psi	Do not exceed 3000 psi	MIL-DTL-8790

Table 1. Hose Specifications and Applications (Cont)

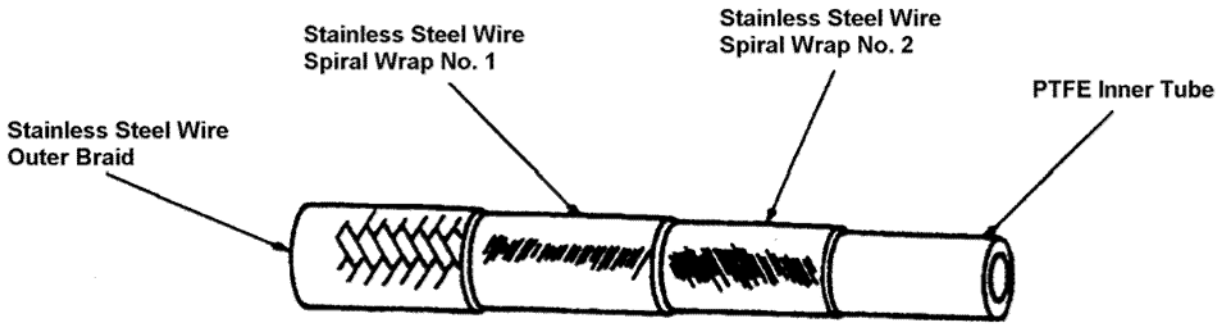
High-Pressure PTFE Hose MIL-DTL-83298					
 003t01g					
Construction Material			**Intended Use**	**Cautions**	**Use To Fabricate Hose Assy**
Inner Tube	**Reinforcement**	**Outer Cover**			
Virgin tetra-fluoroethylene resin	The method of reinforcement changes according to hose size: Size -4, two braids or two spiral wraps plus one braid. Size -6 and -8, two spiral wraps plus one braid. Size -10 and up, four spiral wraps plus one braid.		Aircraft and missile high-pressure (3000 psi) hydraulic and pneumatic systems at a temperature range of -65° to +400°F	Do not use hose assembly in pneumatic storage systems. Use only MIL-F-83296 fittings on hose assembly.	AS 604 AS 1339

Table 2. Identification of Aerospace Hydraulic, Fuel, Oil, Coolant, and Instrument Hoses for Use in Systems as indicated Below

SPEC NUMBER	DESCRIPTION / USE	IDENTIFICATION MARKINGS	HYD	FUEL	OIL	COOLANT	WATER & ALCOHOL	PNEU-MATIC
Low Pressure Hose								
MIL-DTL-5593 [1]	Instrument lines only. Use to fabricate low pressure hose assemblies with reusable end fittings. AN 6270 assemblies.	CAGE code, Spec No., or LP; size, quarter year, and year of manufacturer in yellow. Rubber cover	No	No	No	No	No	No
MIL-DTL-6000 [2]	Operating temp 250ºF. Use when flame resistant hose is not required. When lengths in excess of 18 inches are required, use hose spec MIL-DTL-7938.	CAGE code in red. Spec. No., size, quarter year, and year of manufacture in white.	Yes	Yes	Yes	Yes	Yes	No
MIL-DTL-7938	Flame resistant. Use with hose clamps.	CAGE code in white. Spec. No., size, quarter year, and year of manufacture in red.	Yes	Yes	Yes	Yes	Yes	No
MIL-DTL-7061 [3] (AF only)	Self-sealing. When exhausted, use hose spec MIL-DTL-6000 or MIL-DTL-7938	CAGE code, or name. Proprietary No., either AR-184, AR-145, AR-250, or AR-277. Quarter year of manufacture in red above a solid red stripe.	No	Yes [1]	No	No	No	No
Medium Pressure Hose								
MIL-DTL-8794	Use to fabricate medium pressure hose assemblies with reusable fittings. MIL-DTL-8795 assemblies.	Manufacturer's code (CAGE), spec no. size, quarter year, and year of manufacture in yellow.	Yes	Yes	Yes	No	Yes	Yes

Table 2. Identification of Aerospace Hydraulic, Fuel, Oil, Coolant, and Instrument Hoses for Use in Systems as Indicated Below (Cont.)

SPEC NUMBER	DESCRIPTION / USE	IDENTIFICATION MARKINGS	HYD	FUEL	OIL	COOLANT	WATER & ALCOHOL	PNEU-MATIC
Medium Pressure, Light Weight Hose								
Aeroquip 601 / Stratoflex 156 (AF only)	Operating temperature -40° to 300°F. Fuel and oil lines on jet engines.	Tape Aeroquip 601 size or Stratoflex size	Yes [4]	Yes	Yes	Yes (No for Stratoflex)	No	No
MIL-DTL-83797 (Navy Only)	Operating temperature -65° to 250°F. Hydraulic, fuel, and petroleum base systems. MIL-DTL-83796 assemblies.	Metal Band with CAGE code, Spec. No., size, quarter year, and year of manufacture.	Yes	Yes	Yes	No	No	No
PTFE Medium Pressure Hose								
MIL-DTL-27267	Operating temperature -65°F to 450°F. MIL-DTL-25579 assemblies.	Metal Band with operating PSI and CAGE code	Yes	Yes	Yes	Yes	Yes	Yes
High Pressure Hose								
MIL-DTL-8788 [5]	MIL-DTL-8790 assemblies.	CAGE code, spec no. size, quarter year, and year of manufacture in yellow.	Yes	Yes	Yes	Yes	Yes	Yes
PTFE High Pressure Hose								
MIL-DTL-83298	Operating temperature -65°F to 450°F. AS604/AS1339 assemblies (formerly MIL-DTL-38360)	Metal or pliable plastic bands with hose spec., size, operating psi and CAGE code	Yes	Yes	Yes	Yes	Yes	Yes

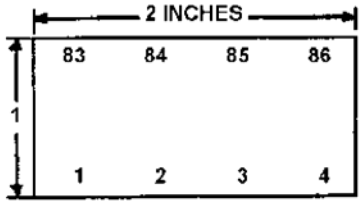
1 Do not use on high pressure jet engine fuel systems. (AF comment)

2 Use only as a non-pressurized line, unless applicable aircraft TO or MIM explicitly requires use as a pressurized line.

3 In view of installation difficulties, hose specification MIL-DTL-7061, in sizes 5/8, ¾, and 1-¼ inch ID, has been reinstated for procurement and will be used for fuel lines. This is primarily due to the fact that been radii of hose Specification MIL-DTL-7061 is less than same sizes of either hose specifications MIL-DTL-6000 of MIL-DTL-7938. When hose specification MIL-DTL-7061 in sizes over 1-¼ inch ID is exhausted, requirements will be met by using hose specification MIL-DTL-6000 of MIL-DTL-7938.

4 Aeroquip 601: Hydraulic suction and return lines only.

5 When fire resistance is required, install silicone fire sleeve.



(MATERIAL: WHITE POLYESTER FILM PER MIL-P-38477)

NOTES:

1. LETTERS AND NUMBERS TO BE 3/32 INCH HIGH, SPACED APPROXIMATELY AS SHOWN.
2. LETTERS AND NUMBERS TO BE APPLIED BY PEN OR SILK SCREENING (ANY DARK COLOR), USING 3M 4100 SERIES SCREENING PAINTS.
3. YEAR NUMBERS TO BE CURRENT, AND AT LEAST ONE SUBSEQUENT, AT TIME OF LABEL MANUFACTURE.
4. MAXIMUM OPERATING PRESSURE FROM APPLICABLE HOSE SPECIFICATION.
5. CODE OF HOSE ASSEMBLY FABRICATOR. USE CODES LISTED IN FEDERAL SUPPLY CODE FOR MANUFACTURES, CATALOGING HANDBOOKS H4-1 AND H4-2.
6. FOR ALL LABELS MANUFACTURED, ADD USER'S MANUFACTURER'S CODE (OPPOSITE FAB BY) IN ACCORDANCE WITH NOTES.
7. ENTER APPROPRIATE HOSE ASSEMBLY PART NUMBER IN SPACE PROVIDED.

003003

Figure 1. Fabricating Instructions for Hose Assembly Labels

13. HOSE FITTINGS.

14. Hose fittings are designed and constructed in accordance with military specifications and military standard drawings for particular hose configurations and operating pressures.

15. FITTING DASH NUMBERS. Fittings designated by a military standard drawing number have a particular dash number to indicate size. The fitting dash number does not designate a size in the same manner as a hose dash number. The fitting dash number corresponds to the dash number of the hose so that both will match at the critical dimensions to form a hose assembly.

16. MATERIALS USED. Materials used in the construction of fittings vary according to the application. Materials include aluminum, carbon steel, and Corrosion-Resistant Steel (CRES). Fittings which qualify under one military document may be produced by several manufacturers.

17. HOSE FITTING DESCRIPTION AND APPLICATION. Hose fittings are assemblies of separate parts. Each fitting has a nipple, a socket, and a swivel nut or flange. The nipple is the part that fits the inside diameter of the hose. The socket fits over the outside diameter of the hose and secures one end of the nipple to the hose. The swivel nut or flange secures the other end of the nipple to the mating connection in the fluid system. For Teflon hose, some manufacturers have a sleeve in addition to the nipple, socket and nut or flange (Figure 2, Sheet 4).

Individual parts produced by each manufacturer may have unique characteristics and tolerances which prevent the interchanging of parts. Do not intermix nipples and sockets from one manufacturer to another.

18. Nipple Configurations. Nipples have three configurations for the hose-to-tube or component surface sealing portion. One configuration, known as flared, is cone shaped 37 degrees at the sealing surface as shown in Figure 2, Sheet 1. Another configuration, flareless, is shown in Figure 2, Sheet 2. A third configuration, flanged, is in Figure 2, Sheets 3 and 5.

19. HOSE FITTING IDENTIFICATIONS. Hose fittings are identified by applicable MS and manufacturer name or trademark on fittings and nuts. Flared or flareless fittings and nuts are color coded to show materials or material finishes (Table 3).

20. INSTALLING HOSE FITTINGS. Two methods are used to secure the hose fitting onto the hose:

a. The reusable style has modified internal threads in the socket to grip the hose properly. The fitting can be disassembled from a hose assembly and reused on another hose, provided it passes inspection for defects as specified in WP006 00.

b. The permanent swage or crimp style which requires the socket to be permanently deformed by electric or hydraulic powered machine. The deformed socket and related hardware shall be scrapped.

Table 3. Hose Fitting Color and Material Code

Flared Fittings MIL-F-5509	Color	Material Code
Aluminum Alloy 2014 and 2024 (1)	Blue	D (Optional)
Aluminum	Brown	W (T-73)
Steel	Black	
Copper Based Alloy	Natural Cadmium Plate if applicable	
Corrosion Resistant Steel	None	
Class 304		J
Class 316		K
Class 347		S
Titanium Alloy	Gray	T

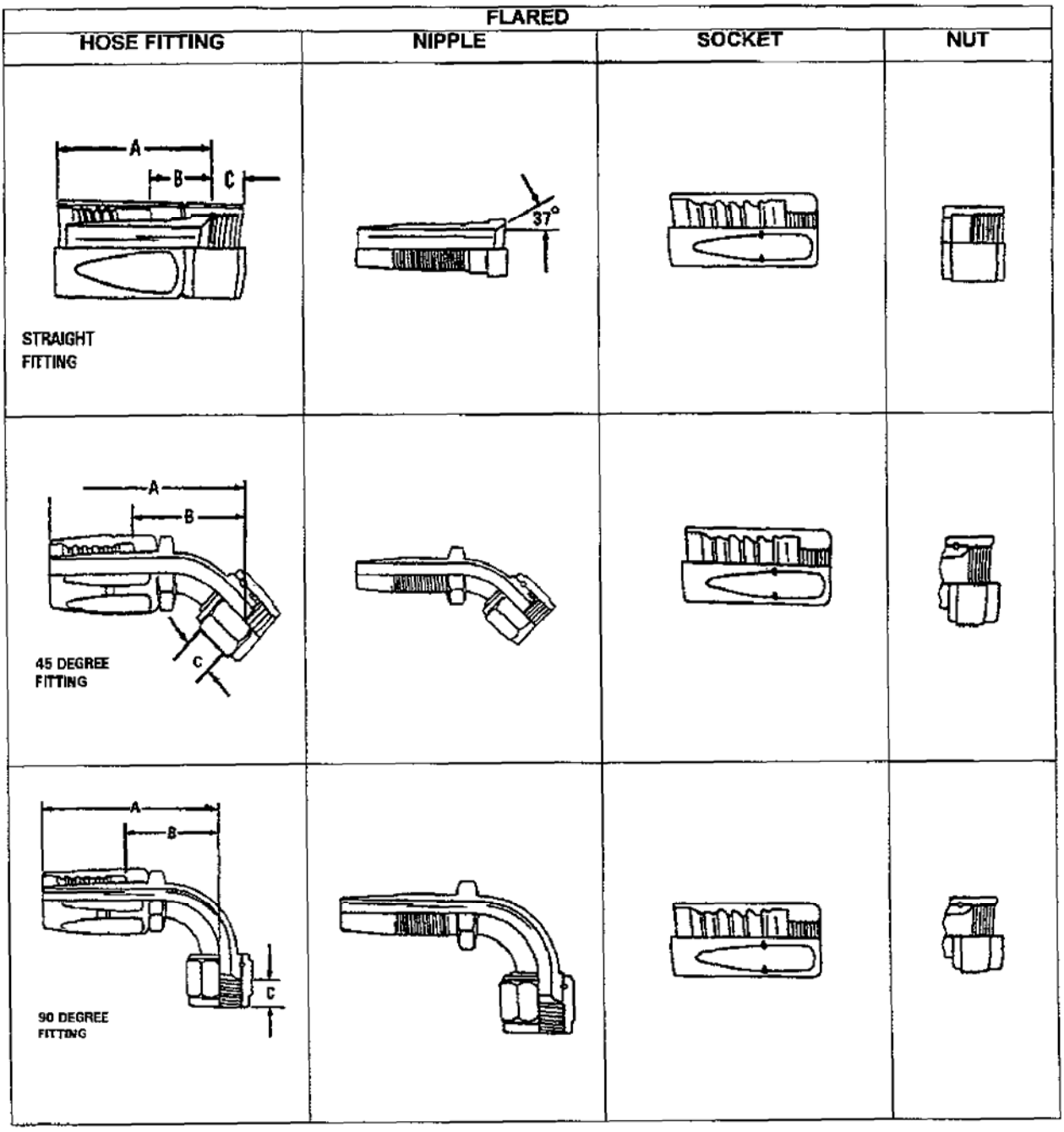
NOTE

(1) Duplex steel may distort color of aluminum anodize

Flareless Fittings SAE AS 18280	Color	Material Code
Aluminum Alloy 2014 and 2024	Green	D
Aluminum Alloy 7075	Brown	W (T-73)
Carbon Steel	Yellow (result of chromate treatment)	
4130 Steel Forging		F
Stainless Steel	Natural Finish	
Class 304		J
Class 316		K
Class 321		R
Class 347		S
Titanium Alloy	Gray	T

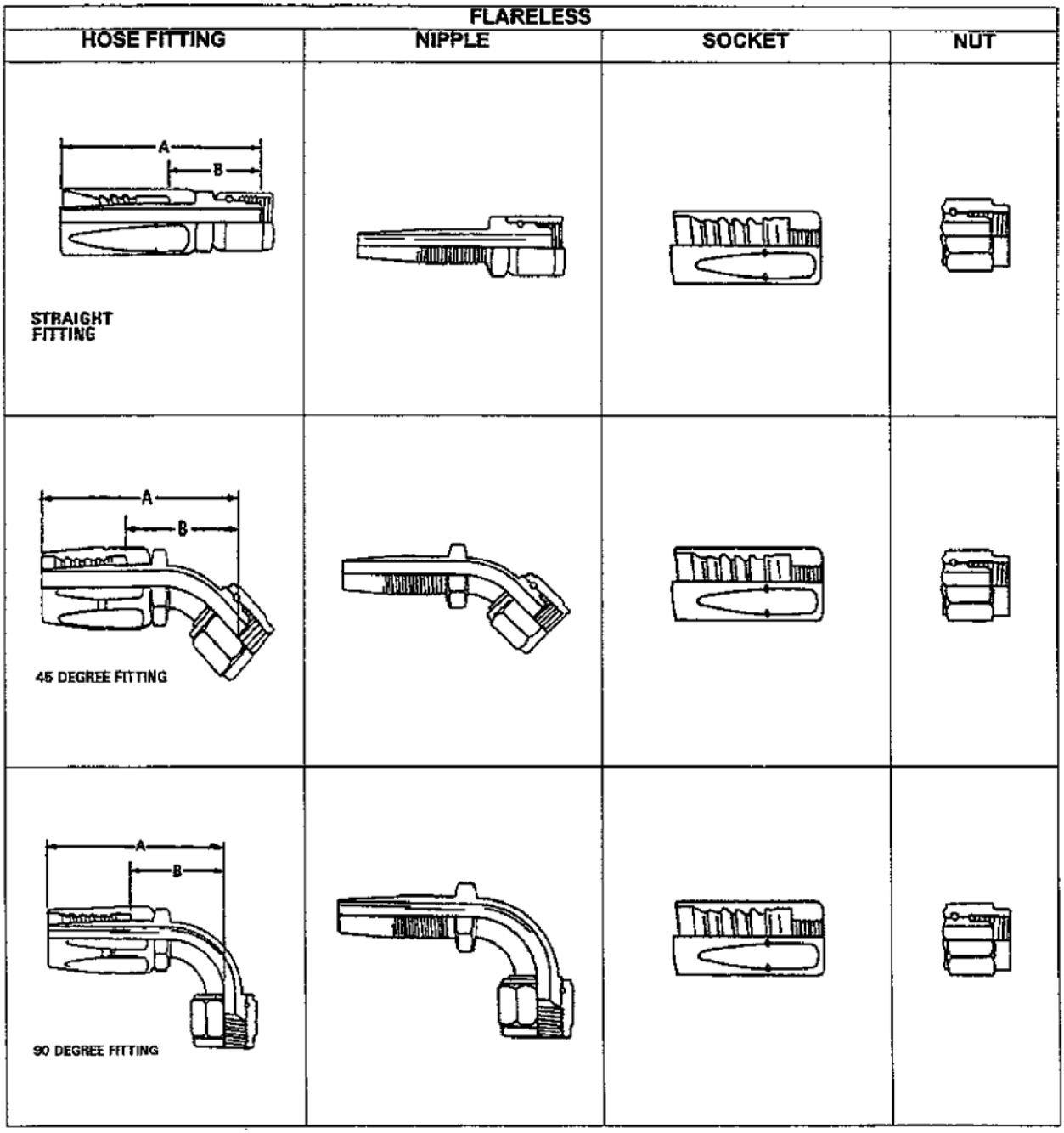
NOTE

When fabricating replacement hose assemblies, reusable style fittings are authorized replacement fittings for all but Egress, Oxygen and Fire Extinguisher applications. Egress, Oxygen and Fire Extinguisher systems are considered flight critical and often have unique hose fitting requirements/restrictions. Prior to the manufacture of Egress, Oxygen and Fire Extinguisher system hoses, refer to original assembly, manufacturing drawing, applicable Hose and Tube Maintenance Instruction Manuals, and/or applicable Fleet Support Team (FST) to verify authorization for the use of reusable style fittings in lieu of permanent swage or crimp style fittings and vice versa.



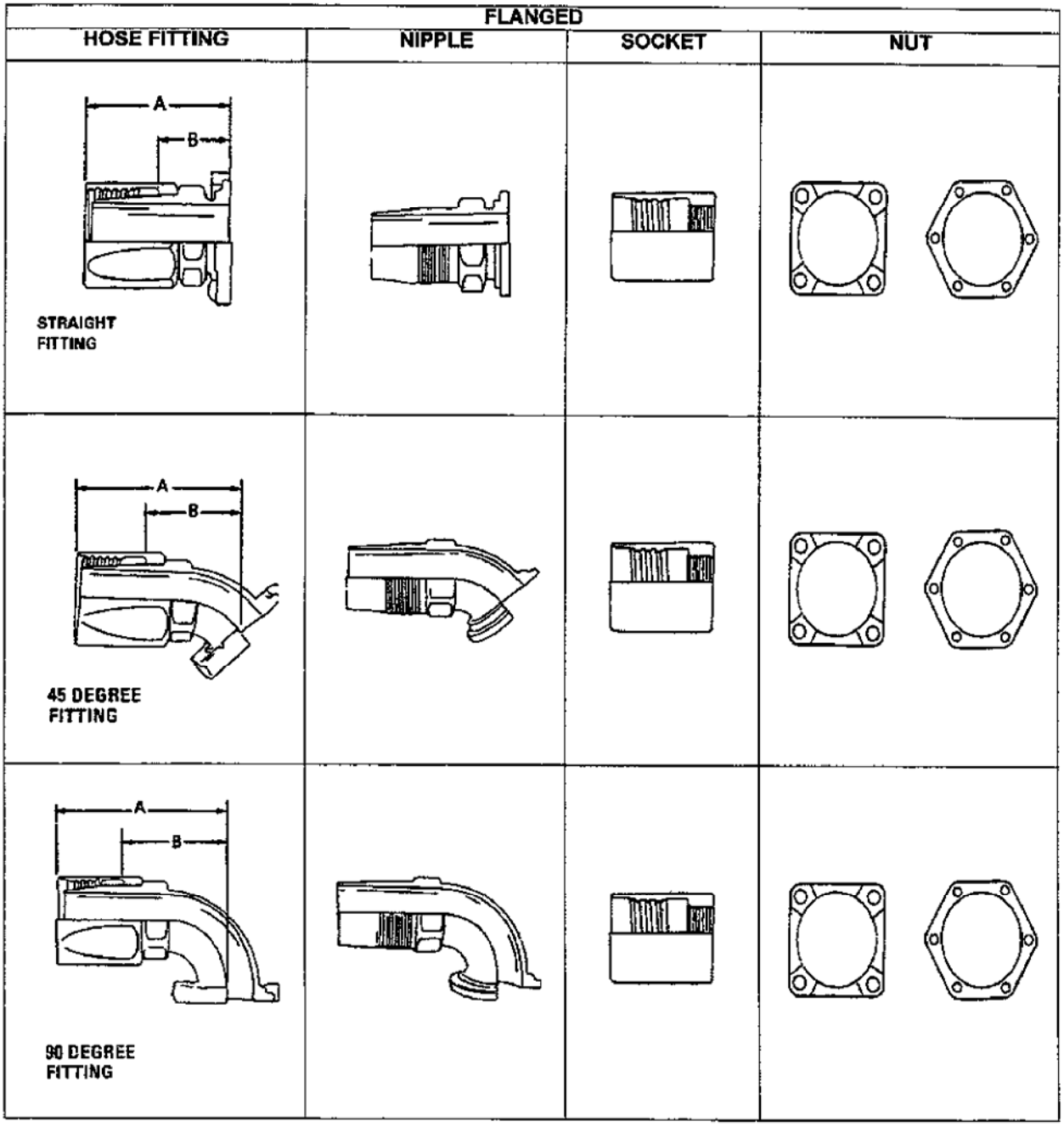
00300401

Figure 2. Hose Fittings (Sheet 1 of 5)



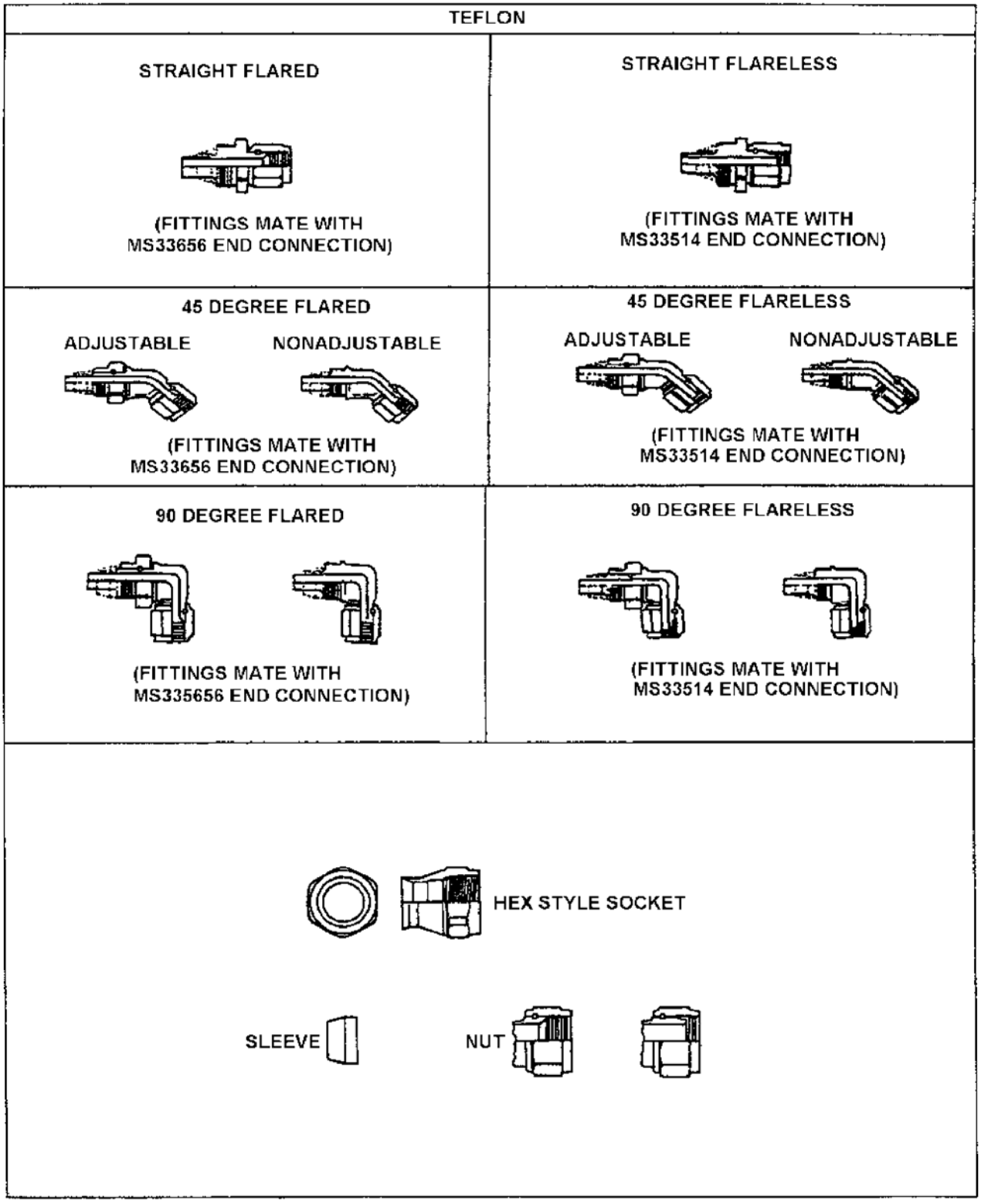
00300402

Figure 2. Hose Fittings (Sheet 2 of 5)



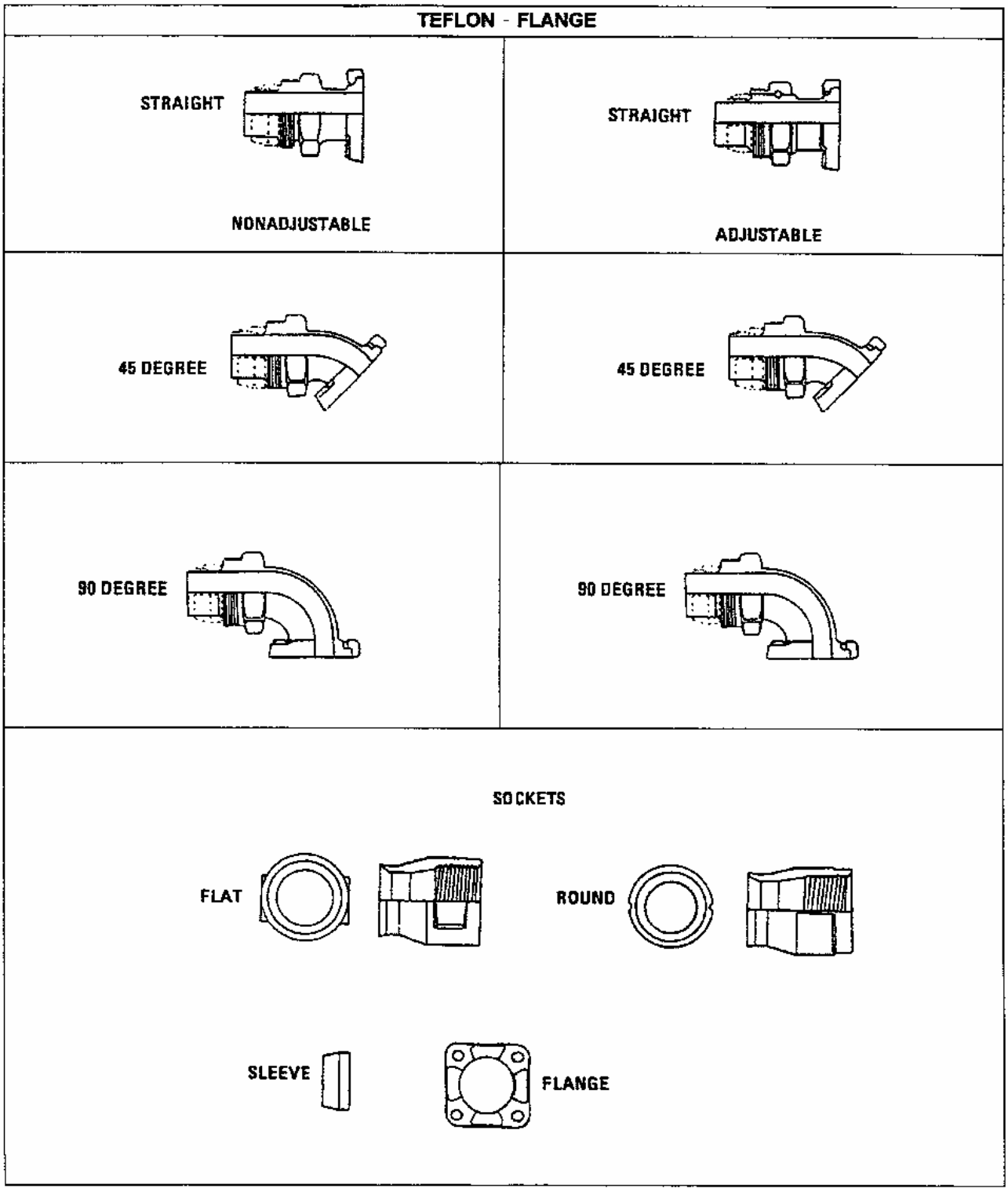
00300403

Figure 2. Hose Fittings (Sheet 3 of 5)



00300404

Figure 2. Hose Fittings (Sheet 4 of 5)



00300405

Figure 2. Hose Fittings (Sheet 5 of 5)

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

FABRICATION

GENERAL HOSE ASSEMBLY PROCEDURES

Reference Material

Bulk Hoses and Fittings, Description WP003 00
Hose Assembly, Maintenance and Installation WP005 00
Hose Assembly, Inspection, Storage, and Age Control WP006 00
Fuel and Hydraulic System Protective Closures, Description WP007 00
Aviation Crew Systems Oxygen Equipment ..... NAVAIR 13-1-6.4 Series
Hose Assemblies, Rubber Hydraulic, High-Pressure (3000 psi) MIL-DTL-8790
Hose Assemblies, Rubber Hydraulic, Fuel- and Oil-Resistant MIL-DTL-8795
Hose Assembly - Detachable Swivel Fitting, Low-Pressure AN6270
Hose Assembly, Rubber, Lightweight, Medium-Pressure, General Specification for MIL-DTL-83796
Hose Assembly, Tetrafluoroethylene, High Temperature, Medium-Pressure MIL-DTL-25579

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Record of Applicable Technical Directives

None

1. GENERAL.

2. Fabricating hose assemblies from bulk hose and reusable end fittings requires some basic skills and a few hand tools. The skills required are the ability to follow step-by-step instructions and the ability to manipulate the hand tools required.

WARNING

When cutting or stripping nylon core and synthetic rubber with a high speed cutting machine, ensure proper ventilation is available and approved by local Occupational Safety and Health.

3. HOSE ASSEMBLIES.

4. Hose assemblies are designated by a particular drawing number and a series of dash numbers or letters which denote size, length of assembly, type and kind of fitting, and angular measurement when elbow fittings are required. Hose assembly specifications and instructions for assembly are presented in the following sub Work Packages:

a. WP 004 01: Disassembly **(Air Force Only)**

b. WP 004 02: Low and Medium Pressure Rubber Hose Assemblies:

- AN 6270,
- MIL-DTL-6000,
- MIL-DTL-7938,
- MIL-DTL-7061 **(Air Force Only)**
- MIL-DTL-8795

d. WP 004 03: Medium Pressure, Light Weight Hose Assemblies:

- Aeroquip 601 / Stratoflex 156
- MIL-DTL-83796

e. WP 004 04: PTFE Medium Pressure and PTFE High Pressure Hose Assemblies:

- MIL-DTL-25579
- MIL-DTL-8790

f. WP 004 05: High Pressure Rubber Hose Assemblies:

- AS604 / AS1339 (formerly MIL-H-38360)

NOTE

Many ‘MS’ part numbers have been changed to ‘AS’ part numbers. Cross referencing ‘AS’ part numbers to ‘MS’ part numbers may be necessary in some cases.

5. HOSE ASSEMBLY APPLICATION. Hose assemblies are used in fluid systems where flexibility is required. For example, landing gear or wheel brakes require hose for flexibility, whereas operating pumps require hose assemblies as vibration isolators.

a. Engine, oxygen, and ballistic hose assemblies. Hose for oxygen or ballistic systems shall be procured from a qualified commercial source (source code P series). When these hose assemblies are unavailable and could cause a work stoppage, Depot and Intermediate maintenance activities are authorized to fabricate them. Engine, oxygen, and ballistic hose assemblies shall be fabricated per applicable maintenance instruction manuals/assembly specifications and shall meet performance specifications for intended end use.

b. The requirements of this manual apply for fabrication, handling, storage and installation. Engine hose assemblies have both ends connected to the engine, and are listed in applicable Illustrated Parts Breakdown (IPB) for the engine model specified. Ballistic hose assemblies used in escape systems are classified as critical assemblies.

6. HOSE ASSEMBLY IDENTIFICATION.

7. All hose assemblies are identified by tags, bands, or tapes (Figures 1 and 2). Some identifications are permanently marked while others are removable. Removable tags, bands, or tapes shall not be installed on hose assemblies located inside fuel and oil tanks, hoses external to the aircraft, or in areas of any aircraft where tags, bands, or tapes could be drawn into the engine intake.

CAUTION

Do not remove identification tags of hose assemblies except those listed in Paragraphs 13 and 14.

NOTE

Hoses external to an aircraft do not require hose tags. Etch information from paragraph 10 on the fitting flat. If there is not room for the information in paragraph 10, the minimum information is the assembly date.

8. Commercially Fabricated Hose Assembly Identification. Commercially manufactured synthetic rubber hose assemblies are identified by a band with the following information near one end of the assembly:

a. Assembly manufacturer's code or trademark.

b. MS or AS part number, including dash size.

c. Operating pressure in pounds per square inch (psi).

d. Date of assembly in quarter and year.

e. Hose manufacturer's code number (if different from assembly manufacturer).

f. Cure date of hose manufacture in quarter and year.

9. Polytetrafluoroethylene (PTFE) Hose Assembly Identification. Commercially manufactured Teflon® hose assemblies are identified by a permanently marked and attached band on the assembly. The band contains the following information:

a. Assembly manufacturer's name or trademark.

b. Hose manufacturer's Federal Supply Code number.

c. Hose assembly part number.

d. Operating pressure in pounds per square inch (psi).

e. Pressure Test (PT) symbol.

f. Date of hose assembly manufacture in month and year.

SEE IRAC #9

10. Locally Fabricated Hose Assembly Identification. Hose assemblies manufactured by Depot activities shall have a metal tag. The metal tag shall contain the following information as shown in Figure 2:

a. Organizational code (OPNAV 4790.2(Navy) of activity fabricating hose assembly.

b. Operating pressure in pounds per square inch (psi).

c. Date of fabrication in quarter of year and year.

d. Basic hose assembly and part number.

11. Installing Removable Identifications. All marking shall be done before attaching tags, bands, or tapes to hose assembly. Do not attempt to mark a removable identification while it is attached to a hose assembly. Removable identifications shall not be placed nearer than 1/2 inch to the end fitting after proof pressure testing. Install removable identifications as follows:

a. Wrap band snugly around hose.

b. Insert tab through slot and pull tight.

c. Crimp the tab after bending tab back.

d. Cut away excess tab after crimping.

CAUTION

Do not allow shrink tubing to contact fitting. Allow 1/2 inch clearance between fitting and shrink tubing.

12. Hose Assembly Identification Label (Figure 2). Hose assemblies covered with heat shrinkable tubing or hose assemblies located in areas where a tag may be drawn into an engine intake shall be identified by use of labels. Place label one inch from socket and apply a 2 1/2-inch piece of clear heat shrinkable tubing MIL-PRF-46846 type V over label and hose. Function and hazard labels can be applied in the same manner as described above.

NOTE

Hoses external to an aircraft do not require hose tags. Etch information from paragraph 10 on the fitting flat. If there is not room for the information in paragraph 10, the minimum information is the assembly date.

13. Identifying Fuel or Oil Tank Hose Assemblies. Do not tag hose assemblies to be installed in fuel or oil tanks. These hose assemblies shall be

marked with an Electro-Vibro pencil on the socket wrench flats with information as required in Paragraph 10.

14. When metal identification tags are installed on hose assemblies having an exterior braid of stainless steel (Figure 1), a protective wrap of shrink tubing will be applied to the hose assembly prior to installation of the identification tag. The procedure for installing identification tags to hose assemblies with exterior braid of stainless steel is as follows:

NOTE

Use the smallest diameter heat shrinkable tubing that will fit over the hose. MIL-PRF-46846 Type V heat-shrinkable tubing may be used as an alternate shrinkable tubing for larger size hoses (-24 through -48).

a. After one end fitting has been attached but before attaching the other end fitting, cut a 1-1/2 inch length of heat-shrinkable tubing, AMS-DTL-23053/8 and slide it over the hose.

b. Complete the fabrication of the hose assembly as specified in the following sub work packages (WP 004 xx).

c. Position the heat shrink tube approximately one inch from end fitting and shrink it into place using a heat gun.

d. Attach the metal identification tag at the center of the shrink tubing.

15. FIRESLEEVES.

Materials Required

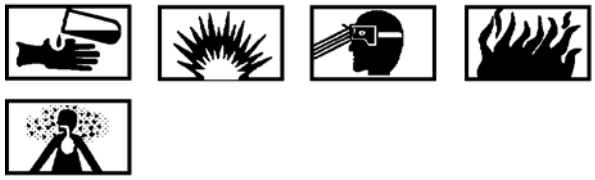
Specification or Part Number	Nomenclature
AS 1072	Firesleeve
MIL-A-46146, Type II	Adhesive
MIL-DTL-27267	Hose
MIL-DTL-83298	Hose
MIL-DTL-83797	Hose
MIL-DTL-8788	Hose
MIL-DTL-8794	Hose
900591B	Clamp, Firesleeve
1081	Clamp, Firesleeve

16. Some hose assemblies are located in areas where temperatures exceed the capabilities of the hose material. Protective firesleeve AS 1072 shall be installed over these hose assemblies. Firesleeves do not increase service temperature of hoses, but protect hose from direct fire long enough to allow appropriate action to be taken. The sleeve is composed of fiberglass impregnated and overlaid with a flame-resistant silicone rubber.

17. INSTALLATION. When fabricating a new hose assembly with a firesleeve, firesleeve is installed after one end fitting is installed. The following sequence of steps shall be taken to install firesleeves on hose assemblies.

a. Select size and type of material for firesleeving that will fit snugly over hose. Select correct size of firesleeve clamp (Tables 1 and 2).

b. Cut off a length of firesleeving long enough to cover both end fitting sockets without interfering with swivel nuts (Figure 3).



Adhesive, MIL-A-46146, Type II 5

c. Apply one coat of silicone rubber insulating compound MIL-A-46146, Type II to cut to prevent fraying. Allow coating to dry for 24 hours at ambient temperature (60°F or higher).

d. Slip firesleeve over hose until one end is over socket.

e. Secure firesleeve to fitting socket with firesleeve clamp 900591B (00624), 1081 (98441), or equivalent (Figure 4).

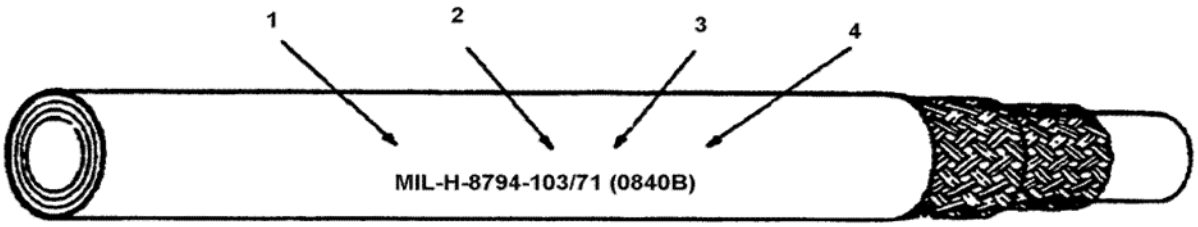
f. Pull firesleeve toward assembled end fitting. Temporarily secure firesleeve with masking tape until second end fitting is assembled.

g. Assemble second end fitting per this section.

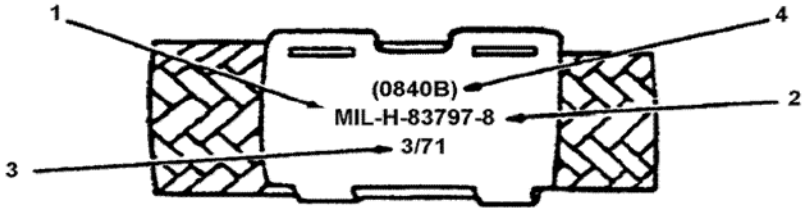
h. Remove masking tape and slide firesleeve over end fitting installed in step (f).

i. Secure sleeve as instructed in step (e).

j. Clean, inspect, test, identify, and prepare for installation or storage per WP003 00 thru WP006 00.



SYNTHETIC RUBBER HOSE



WIRE BRAID COVERED SYNTHETIC RUBBER HOSE

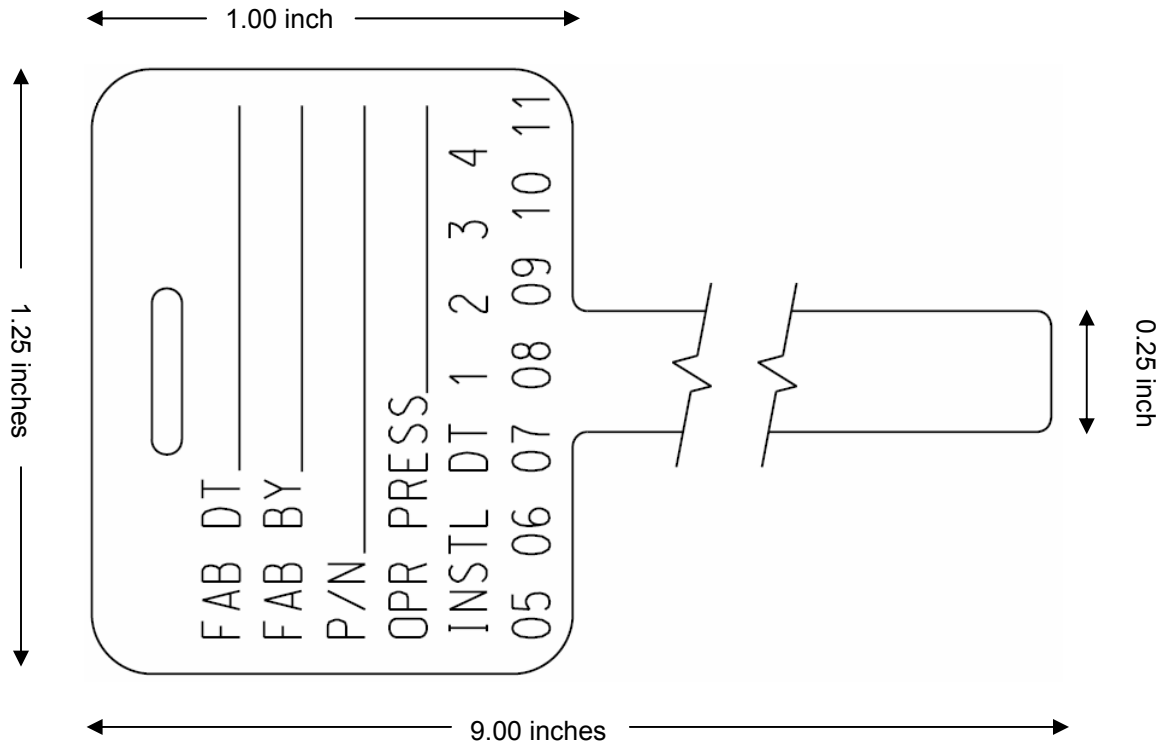
1. MILITARY SPECIFICATION OF HOSE
2. SIZE INDICATED BY A DASH (-) NO. OR FRACTION OF AN INCH FOR MIL-DTL-6000 HOSE
3. CURE DATE FOR AGE CONTROL
4. MANUFACTURER'S FEDERAL SUPPLY CODE NO.

MANUFACTURER	ACME
MANUFACTURER'S CODE	0840B
PART NO. WITH DASH (SIZE) NO.	AB123-10
LOT NO.	16160
OPERATING PRESSURE	3000 PSI
MILITARY SPECIFICATION	MIL-H-83298

WIRE BRAID COVERED PTFE HOSE LABEL

003001

Figure 1. Hose Identification



NOTES:

1. Material: 9 X 1.25 X 0.010 CRES. AMS 5516, Annealed.
2. Letters and numbers to be engraved or embossed.
3. Letters and numbers are 0.08 inch high.
4. Dates shown on drawing are for reference only. The current year plus two consecutive increments must appear.
5. Cherry Point drawing 1C3415

Figure 2. Fabricating Instructions for Hose Assembly Identification Tags

Table 1. Hose, Fire-Resistant Sleeve, and Clamp Size Relationship

Hose	Hose Dash Size	Hose OD	AS1072 Fire-Resistant Sleeve Dash Size (Notes 1 thru 3)	Preformed 900591B Size C or 10781 - XXCR Band Clamp Size
MIL-DTL-8794 Medium-Pressure Rubber	-3	.453	-8	1C/-22
	-4	.516	-9	1C/-22
	-5	.578	-10	2C/-22
	-6	.672	-12	2C/-22
	-8	.766	-13/-14	2C/-22
	-10	.9220	-16	3C/-32
	-12	1.078	-18/-20	3C/-32
	-16	1.234	-22	3C/-32
	-20	1.500	-28	4C/-48
	-24	1.750	-30	4C/-48
	-32	2.219	-38	5C/-48
MIL-DTL-8788 High-Pressure Rubber	-4	.625	-11/-12	2C/-22
	-6	.766	-14	2C/-22
	-8	.859	-16	2C/-22
	-10	1.031	-18	3C/-32
	-12	1.219	-20/-22	3C/-32
	-16	1.500	-26/-28	4C/-48
MIL-DTL-83797 Medium-Pressure Rubber	-3	.375	-7	1C/-22
	-4	.438	-8	1C/-22
	-5	.484	-9	2C/-22
	-6	.547	-10/-12	2C/-22
	-8	.650	-12/-14	2C/-22
	-10	.797	-16	2C/-22
	-12	.938	-18/-20	2C/-32
	-16	1.156	-22/-24	3C/-32
	-20	1.437	-26/-30	4C/-48
	-24	1.704	-30	4C/-48
	-32	2.102	-38	5C/-48
MIL-DTL-27267 Medium-Pressure PTFE	-3	.252	-5/-8	1C/-22
	-4	.324	-6/-8	1C/-22
	-5	.386	-7/-8	1C/-22
	-6	.450	-8/-11	2C/-22
	-8	.566	-10/-13	2C/-22
	-10	.664	-11/-14	2C/-22

Table 1. Hose, Fire-Resistant Sleeve, and Clamp Size Relationship (Cont)

Hose	Hose Dash Size	Hose OD	AS1072 Fire-Resistant Sleeve Dash Size (Notes 1 thru 3)	Preformed 900591B Size C or 10781 - XXCR Band Clamp Size
MIL-DTL-27267 Medium-Pressure PTFE (Cont)	-12 -16 -20 -24	.789 1.109 1.359 1.672	-14/-18 -18/-24 -24/-28 -30/-38	2C/-22 3C/-22 4C/-32 5C/-48
MIL-DTL-83298 High-Pressure PTFE	-4 -6 -8 -10	.455 .550 .727 .865	-9/-11 -11/-13 -13/-16 -16/-20	1C/-22 2C/-22 2C/-22 2C/-22

Notes:
1. Sleeve sizes shown are for assembly over straight end fittings.
2. Hose assemblies with an elbow or jump fitting on each end shall use sleeve sizes shown, except that sleeve is installed prior to assembly of second end fitting.
3. Where no single size is shown, use the smaller of the two sizes that can be easily installed over the hose assemblies.

Table 2. Fire-Resistant Sleeve AS 1072 Data

Sleeve Dash Size	Sleeve ID	Wall Thickness (Nom)	Weight (lb/ft) (Max)
-4	.25	.125	.08
-5	.36	.125	.09
-6	.38	.125	.10
-7	.44	.125	.13
-8	.50	.125	.14
-9	.56	.125	.16
-10	.62	.125	.20
-11	.69	.125	.21
-12	.75	.125	.22
-13	.81	.125	.25
-14	.88	.125	.26
-16	1.00	.125	.33
-18	1.12	.125	.35
-20	1.25	.125	.37
-22	1.38	.125	.44
-24	1.50	.125	.48
-26	1.62	.125	.38
-28	1.75	.125	.42
-30	1.88	.125	.44
-38	2.38	.125	.46

18. Replacement of Firesleeves. Firesleeves cannot be repaired. Replacement of the firesleeve on hose with straight fittings may be accomplished on hose that is in otherwise good condition. Hose with acute angled end fittings may not be appropriate for replacement of firesleeve. In cases were replacement of the firesleeve is not appropriate, replace the hose assembly.

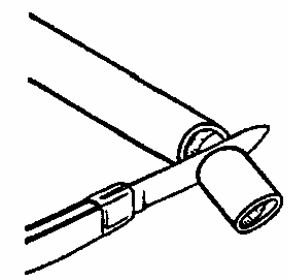


Figure 3. Cutting Firesleeve or Hose

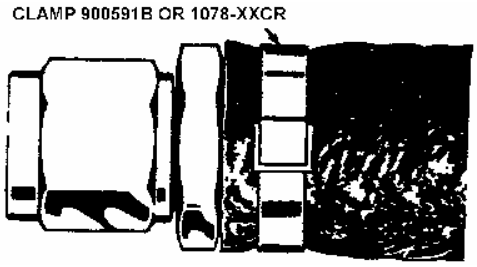


Figure 4. Installing Firesleeve

19. CHAFE GUARDS

20. Installation. Hose chafe guards are heat shrinkable plastic tubing that is sleeved over the hose assembly and heat-shrinking onto the hose with gentle heating. Chafe guards for hose are installed in a similar manner to firesleeves. Install the smallest chafe guard that will fit, generally 2 to 4 dash numbers larger than the hose.

a. For hoses with straight fittings, chafe guards may be installed after the end fittings are installed.

b. For end fittings with angles, slip the chafe guard on the hose prior to installing one of the two ends.

c. Apply heat with a temperature controlled heat gun to shrink the tube to proper dimensions. Never apply temperatures in excess of 300ºF to rubber hose (or 410ºF to PTFE hose) for any reason.

21. Replacement of Chafe Guards. Chafe guards that are worn or cut may be replaced on hose that is in otherwise good condition.

a. Straight end fittings may have chafe guards replaced by removing the old chafe guard and then re-sleeving an appropriate size heat shrinking chafe guard over the hose.

b. Hose with acute angled end fittings may not be appropriate for replacement of chafe guards.

c. In cases were replacement of the chafe guard is not appropriate, replace the hose assembly.

22. CLEANING HOSE OR HOSE ASSEMBLIES.

Materials Required

Specification or Part Number	Nomenclature
A-A-59503	Nitrogen
MIL-C-81302	Trichlorotrifluoroethane
MIL-D-16791	Detergent
MIL-PRF-680	Dry Cleaning Fluid

23. Fabricated hose assemblies shall be cleaned and visually inspected for foreign material before and after proof testing.

Non-Ionic Detergent, MIL-D-16791 **6**

CAUTION

Do not clean oxygen system hoses with MIL-D-16791. See Paragraph 43 for proper procedures.

24. CLEANING FLUIDS. The preferred cleaning fluid for synthetic rubber and PTFE hose assemblies shall be MIL-D-16791, in solution of 1/4 to 1/2 ounce of detergent to one gallon of tap water. The pH of the solution shall be maintained between 8.0 and 9.5.

NOTE

The pH number is a chemical term relating to the acidity or alkalinity of a solution. The pH numbering system is scaled from 0 to 14, with pH 7.0 being neutral. Numbers above 7.0 correspond to increasing alkalinity, below 7.0 increasing acidity.

25. CLEANING PROCEDURES. In cleaning hose or hose assemblies, the cleaning procedures used depend on the cleaning material selected for cleaning. The preferred cleaning method is one that also uses the preferred cleaning material MIL-D-16791 (Paragraph 26).

Trichlorotrifluoroethane, MIL-C-81302 7

Use MIL-C-81302 only in cleaning hose and hose assemblies for oxygen systems.

26. CLEANING HOSE OR HOSE ASSEMBLIES WITH DETERGENT MIL-D-16791. The alternate method for cleaning PTFE or synthetic rubber hose or hose assemblies is to use detergent MIL-D-16791. To clean hose or hose assemblies with detergent MIL-D-16791, proceed as follows:

Non-Ionic Detergent, MIL-D-16791 6

NOTE

For easier cleaning, keep foaming of detergent (MIL-D-16791) solution to a minimum.

a. Immerse or flush hose or hose assembly in a solution made of 1/4 to 1/2 ounce of detergent MIL-D-16791 to 1 gallon of Hot water.

b. Brush exterior of hose or hose assembly with a nylon or similar synthetic bristle brush which has a corrosion-resistant core.

c. Brush the bore and at least the first inch of hose or hose assembly with a brush which has a diameter of at least 1/16 inch larger than the fitting bore.

d. Drain detergent solution and immediately rinse hose or hose assembly thoroughly with tap water to remove all traces of detergent.

Nitrogen, A-A-59503 8

e. Drain water from hose or hose assembly and blow dry with filtered, dry, oil-free air or nitrogen, A-A-59503.

f. If hose or hose assembly is not to be cleaned further or proof tested immediately, install protective closures per WP007 00.

27. (NAVY ONLY) CLEANING OXYGEN SYSTEM HOSES. Clean oxygen hose assemblies using the procedures and materials described in NAVAIR 13-1-6.4 Series.

Dry Cleaning Fluid, MIL-PRF-680 20

28. CLEANING BALLISTIC HOSES. Special precautions will be adhered to for cleaning ballistic hose assemblies. When hydraulic fluid has been used for proof testing, flush the hose assembly thoroughly with MIL-PRF-680, Type III. All evidence of hydraulic fluid residue must be removed.

29. (AIR FORCE ONLY) 601 LITTLE GEM FITTINGS. In some instances when fittings are removed from 601 hose, the rubber may break off and remain under the lipseal of the nipple. Hand tools for the removal of this rubber can be field manufactured utilizing AF Drawing 69D34989.

30. PROOF PRESSURE TESTING.

Materials Required

Specification or Part Number	Nomenclature
A-A-59503	Nitrogen
MIL-PRF-83282	Hydraulic Fluid

31. Hose assemblies shall be proof pressure tested after fabrication.

32. (Navy Only) Oxygen hose assemblies shall be tested by qualified aviation equipment personnel per NAVAIR 13-1-6.4 Series before installation in weapons systems.

33. Ballistic hose assemblies shall be cleaned and tested per applicable maintenance instruction manuals and assembly specifications.

34. HOSE ASSEMBLIES. Observe all safety rules and proceed as follows:

a. Clean hose assembly per Paragraph 25.

b. Select test media from Table 3.

NOTE

Unless otherwise directed, the test media for ambient temperature proof pressure tests shall be selected from Table 3.

c. Select proof pressure from Table 4 or 5.

NOTE

Proof pressure in Table 5 are for hose assemblies with both ends having swivel nut fittings; for an assembly which has one or more aluminum flanges, reduce the proof pressure by one half.

d. Test one hose assembly at a time; however, several hose assemblies requiring the same proof pressures can be tested together if they are connected in series with adapters.

NOTE

Unless otherwise directed, a manifold hose assembly containing different sizes or types of hose will be tested at the lowest proof pressure required by any one size or type contained in the manifold.

e. Arrange hose assemblies as close to horizontal position as possible.

f. Allow trapped air to escape when testing hose assemblies in a liquid test medium. When testing in air or gas medium, test hose assemblies under water so trapped air can escape from the hose braided outer covers. Hose assemblies with firesleeve do not require under water testing.

g. Tighten pressure cap.

h. Apply proof pressure for a minimum of 30 seconds, but no longer than 5 minutes.

i. Check leakage while maintaining proof pressure.

j. After completion of proof pressure test, drain hose assembly and clean per Paragraph 18.

k. Install protective closures (WP007 00).

l. Install identification tag (Paragraph 6).

m. Prepare hose assembly for installation or storage per WP005 00 and WP006 00.

35. PREFORMED HOSE ASSEMBLIES. Preformed hose assemblies (shaped during fabrication process) shall be restrained by wire, molds or jigs to prevent deformation or kinking which may occur as the hose tends to straighten when pressure is applied. Preformed bends shall meet hose drawing specifications within ten degrees after one hour at room temperature (with restraints removed) following proof pressure test. Replace restraints until assembly is to be installed.

36. EQUIPMENT AND TOOLS FOR MANUFACTURING HOSE ASSEMBLIES.

37. Fabricating hose assemblies is a function of Intermediate and Depot Maintenance levels. The Intermediate and Depot shops are equipped with hose fabricating machines (Figure 5) and proof test equipment. Each machine or equipment is supplied with operating instructions.

38. BASIC HAND TOOLS. The following basic hand tools are required to fabricate hose assemblies up to 3000 psi operating pressure.

39. MANDRELS. Mandrels are special hand tools (Figure 6) that are not required but are recommended for fabricating hose assemblies. During hose assembly fabrication, mandrels can be used to protect sealing surfaces, support inner tubes, and guide fitting nipples into hoses. Mandrel part numbers S1051K (00624) or SF2701 (98441) are available in kits.

Support Equipment Required

Part No. or Type Designation	Nomenclature
—	Bench Vise
—	Band Clamp Tool
—	Open-End Wrench Sets
—	Sharp Knife
—	Slip Joint Pliers
—	Oil Can for Lubricating Oil
—	Marking Pencil
—	Small Paint Brush
—	Masking or Plastic Electrical Tape
—	Steel Ruler
—	Thickness Gage (Leaf Type)
—	Protractor

40. HOSE CUT OFF FACTORS

41. Figure 7 depicts how to calculate hose cut length. Refer to Table 6 for cut off factors for use in constructing hose assemblies per Work Packages 004 02 through 004 05.

Table 3. Proof Pressure Test Media

Hose Type	Test Media (Note 1)
Hydraulic	Water, MIL-PRF-83282
Pneumatic or Gaseous	Water, nitrogen, and air (clean, dry, and oil-free)
Oil	Water or nitrogen (clean, dry and oil-free)
Coolant	Water
Fuel (non-sealing)	Water, MIL-PRF-83282
Fuel (self-sealing)	Water, air (clean, dry and oil-free) or nitrogen (clean, dry and oil-free)
Air	Water or air (clean, dry and oil-free)
Instrument	Water or nitrogen, Grade A, Type 1 (A-A-59503)
Notes: 1. Use Flow Cool or Coolanol for systems using Flow Cool or Coolanol.	

Table 4. MIL-DTL-6000 Synthetic Rubber Hose Proof Pressure Test Data

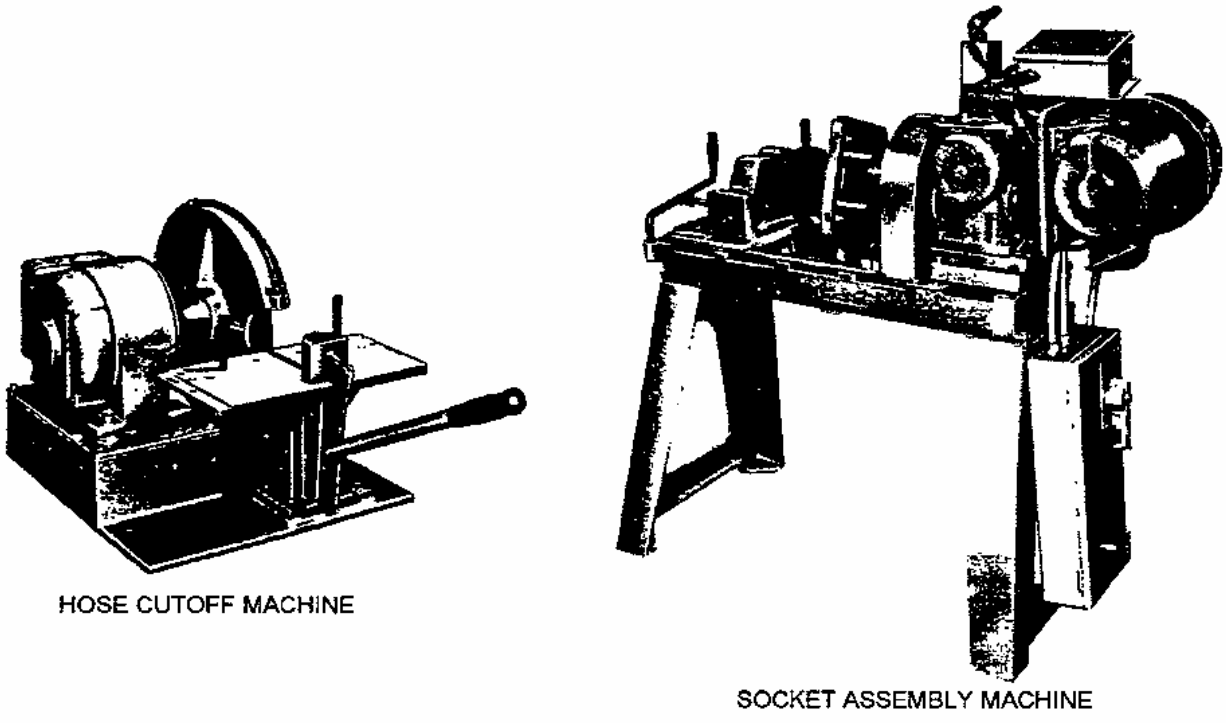
Hose Size (Inches)	Minimum Proof Pressure (psi) (Note 1)	Minimum Burst Pressure (psi) (Note 1)
MIL-DTL-6000		
1/4 - 1	500	1000
1 1/4 - 1 1/2	400	800
1 3/4 - 2	300	600
2 1/2 - 3	200	400
3 1/2	175	350
4	150	300

Notes: 1. Operating pressures are maximum; proof and burst pressures are minimum.

Table 5. Hose Assembly Proof Pressure Test Data

Hose Type and Mil Spec No.		Test Condition (Note 1)	Hose Size (Dash No.)													
			-2	-3	-4	-5	-6	-8	-10	-12	-16	-20	-24	-32	-40	-48
Rubber Low Pressure AN6270		Operating Pressure (Note 2)	300	250	200	---	150	150	150	---	---	---	---	---	---	---
		Proof Pressure (Note 3)	600	500	400	---	300	250	250	---	---	---	---	---	---	---
		Burst Pressure (Note 3)	2000	1700	1250	---	1000	750	700	---	---	---	---	---	---	---
Rubber Medium Pressure MIL-DTL-8795	Hydraulic	Operating Pressure (Note 2)	---	2000	3000	3000	2000	2000	1750	1500	800	600	500	350	---	---
		Proof Pressure (Note 3)	---	4000	6000	5000	4500	4000	3500	3000	1600	1250	1000	700	---	---
		Burst Pressure (Note 3)	---	8000	12000	10000	9000	8000	7000	6000	3200	2500	2000	1400	---	---
	Fuel	Operating Pressure (Note 2)	---	1000	1000	1000	1000	1000	1000	1000	750	500	250	200	200	200
		Proof Pressure (Note 3)	---	1500	1500	1500	1500	1500	1500	1500	1000	750	375	300	300	300
		Burst Pressure (Note 3)	---	8000	12000	10000	9000	8000	7000	6000	3200	2500	2000	1400	1000	800
	Oil	Operating Pressure (Note 2)	---	50	50	50	50	50	50	50	50	50	50	50	---	---
		Proof Pressure (Note 3)	---	600	600	600	600	600	600	600	600	600	600	600	---	---
		Burst Pressure (Note 3)	---	8000	12000	10000	9000	8000	7000	6000	3200	2500	2000	1400	---	---
Rubber High Pressure MIL-DTL-8790		Operating Pressure (Note 2)	---	---	3000	3000	3000	3000	3000	3000	3000	---	---	---	---	---
		Proof Pressure (Note 3)	---	---	8000	7000	7000	7000	6000	6000	5000	---	---	---	---	---
		Burst Pressure (Note 3)	---	---	16000	14000	14000	14000	12000	12000	10000	---	---	---	---	---
Rubber Light Weight Medium Pressure MIL-DTL-83796		Operating Pressure (Note 2)	---	1000	1000	1000	1000	1000	1000	1000	750	500	250	200	---	---
		Proof Pressure (Note 3)	---	3000	3000	3000	3000	2500	2500	2000	1500	1300	800	600	---	---
		Burst Pressure (Note 3)	---	6000	6000	6000	6000	5000	5000	3750	2500	2000	1750	1200	---	---
PTFE Medium Pressure MIL-DTL-25579		Operating Pressure (Note 2)	---	---	1500	1500	1500	1500	1500	1000	1250 (Note 4)	1000 (Note 4)	1000 (Note 4)	---	---	---
		Proof Pressure (Note 3)	---	---	3000	3000	3000	3000	3000	2000	2500 (Note 4)	2000 (Note 4)	2000 (Note 4)	---	---	---
		Burst Pressure (Note 3)	---	---	12000 7000 (Note 5)	10000 6500 (Note 5)	9000 6500 (Note 5)	8000 6000 (Note 5)	7000 5500 (Note 5)	5000 3500 (Note 5)	5000 (Note 4) 3500 (Note 5)	4000 (Note 4) 3000 (Note 5)	4000 (Note 4) 3000[5] (Note 5)	--- ---	--- ---	 ---
PTFE High Pressure AS604/AS1339		Operating Pressure (Note 2)	---	---	3000	---	3000	3000	3000	3000	3000	---	---	---	---	---
		Proof Pressure (Note 3)	---	---	6000	---	6000	6000	6000	6000	6000	---	---	---	---	---
		Burst Pressure (Note 3)	---	---	16000 12000 (Note 5)	---	14000 10500 (Note 5)	14000 10500 (Note 5)	12000 9000 (Note 5)	12000 9000 (Note 5)	12000 9000 (Note 5)	---	---	---	---	---

Notes:
1. Typical operating pressures and burst pressures are included for information purposes only.
2. Pressures are maximum (psi max).
3. Pressures are minimum (psi min).
4. Indicates two braided stainless steel reinforcement layers are mandatory.
5. Indicates high-temperature burst pressures.



004001

Figure 5. Hose Fabricating Machines

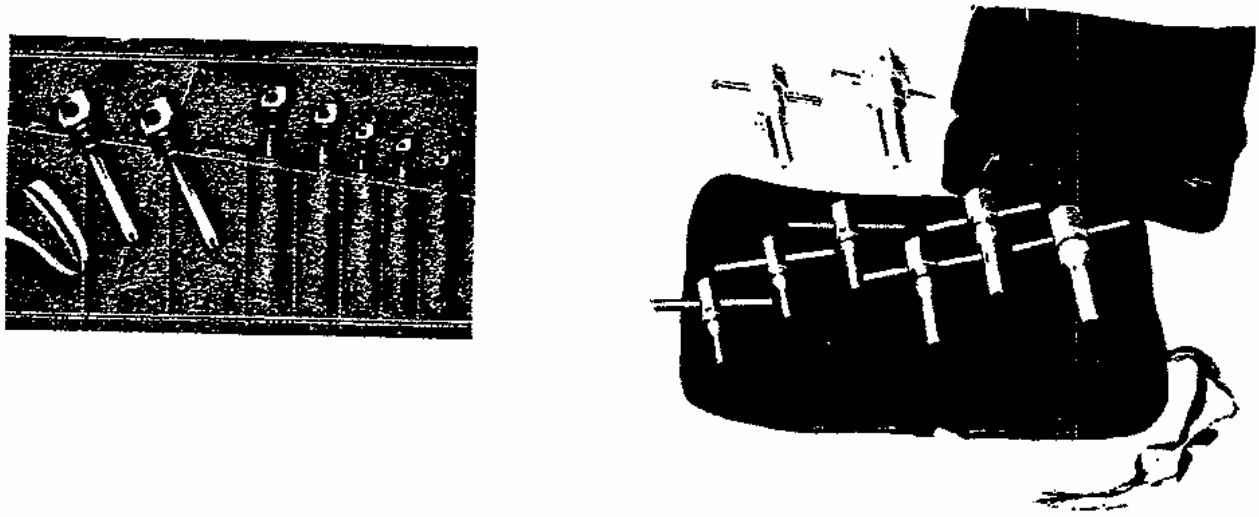


Figure 6. Mandrel Kits

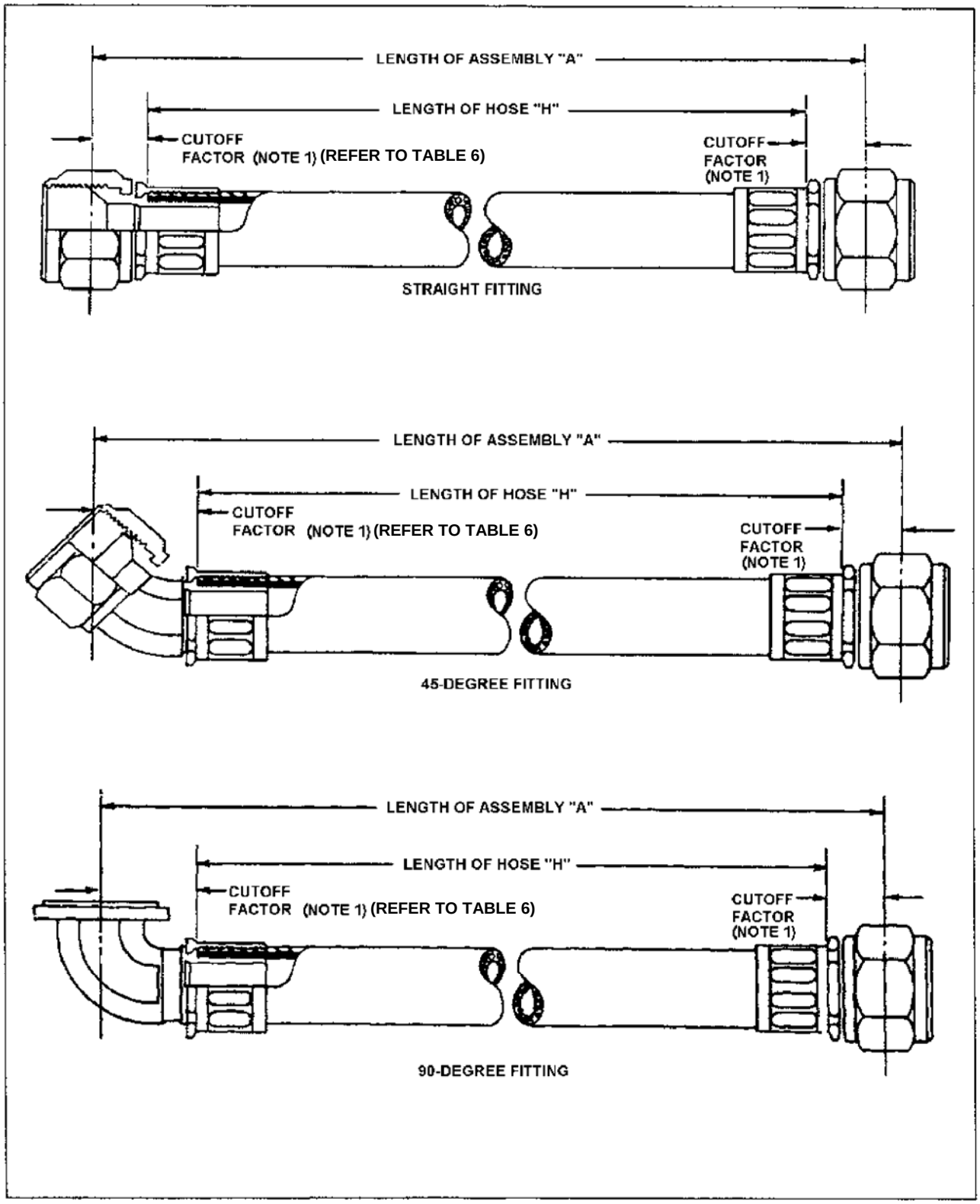
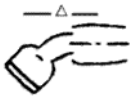


Figure 7. Determining Hose Assembly Length

Table 6. Hose Cutoff Factor (In Inches)

Fitting	Hose Size (Dash No. and/or Letter)											
	Part No.	-3	-4	-5	-6	-8	-10	-12	-16	-20	-24	-32
Straight Flared	MS27616		0.92		1.02	1.16	1.21					
	MS27053	0.70	0.74	0.77	0.81	0.93	1.05	1.13	1.30	1.44	1.66	
	MS28760		0.79		0.99	1.10	1.19	1.35	1.59			
	MS24587	0.60	0.60	0.70	0.77	0.94	1.00	1.00	0.94	0.99	1.09	1.24
004t03a	MS26404		0.46		0.55	0.68	0.73					
	M83798/1											
	(Note 1)	0.64	0.65	0.70	0.76	0.94	0.99	1.00	1.16	1.34	1.44	1.62
	(Note 2)	0.74	0.74	0.76	0.84	0.97	1.05	1.11	1.34	1.54	1.70	2.04

Notes: 1. Cutoff factor for one fitting, Aeroquip.
2. Cutoff factor for one fitting, Stratoflex.

Fitting	Hose Size (Dash No. and/or Letter)											
	Part No.	-3	-4	-5	-6	-8	-10	-12	-16	-20	-24	-32
45 Degree Flared	MS27617		1.58		1.87	2.16	2.36					
	MS27055	1.08	1.18	1.22	1.29	1.79	1.58	2.05	2.14	2.24	2.75	
	MS28780		1.07		1.36	1.45	1.58	2.25	2.47			
	MS27226	1.08	1.12	1.34	1.38	1.55	1.70	1.89	1.85	2.16	2.38	2.84
004t03b	MS27059 (Note 3)	1.08	1.18	1.22	1.29	1.79						
	M83798/2											
	(Note 1)	1.05	1.02	1.12	1.22	1.30	1.44	1.76	1.83	2.13	2.28	2.69
	(Note 2)	0.94	1.07	1.14	1.22	1.31	1.44	1.72	2.03	2.31	2.53	2.91
	(Note 3)	0.77	0.83	0.94	0.97	1.35						

Notes: 1. Cutoff factor for one fitting, Aeroquip.
2. Cutoff factor for one fitting, Stratoflex.
3. Forged elbow.

Table 6. Hose Cutoff Factor (In Inches) (Cont)

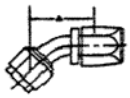
Fitting	Hose Size (Dash No. and/or Letter)											
	Part No.	-3	-4	-5	-6	-8	-10	-12	-16	-20	-24	-32
90 Degree Flared	MS27618		1.12		1.25	1.44	1.59					
	MS27057	0.86	0.91	0.97	1.03	1.31	1.41	1.92	2.05	2.34	2.68	
	MS28781		0.94		1.21	1.29	1.41	2.24	2.53			
	MS27224	0.93	0.99	1.19	1.23	1.39	1.53	1.76	1.76	2.09	2.34	2.80
	MS27060 (Note 3)	0.86	0.91	0.97	1.03	1.31						
004t03c	M83798/3											
	(Note 1)	0.89	0.89	0.96	1.07	1.14	1.27	1.63	1.74	2.06	2.22	2.65
	(Note 2)	0.79	0.94	0.98	1.07	1.15	1.27	1.59	1.93	2.23	2.47	2.86
	(Note 3)	0.56	0.58	0.60	0.72	0.88						

Notes: 1. Cutoff factor for one fitting, Aeroquip.
2. Cutoff factor for one fitting, Stratoflex.
3. Forged elbow.

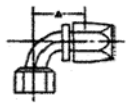
Fitting	Hose Size (Dash No. and/or Letter)											
	Part No.	-3	-4	-5	-6	-8	-10	-12	-16	-20	-24	-32
Straight Flared	MS27629		1.07		1.23	1.39	1.39					
	MS27381	0.92	0.89	0.93	1.02	1.16	1.32	1.40	1.58	1.72	2.07	
	MS28761		0.94		1.17	1.32	1.42	1.60	1.85			
	M83798/4											
004t03d	(Note 1)	0.85	0.80	0.86	0.96	1.17	1.26	1.27	1.44	1.62	1.85	
	(Note 2)	0.95	0.96	1.02	1.09	1.24	1.34	1.50	1.80	2.03		

Notes: 1. Cutoff factor for one fitting, Aeroquip.
2. Cutoff factor for one fitting, Stratoflex.

Table 6. Hose Cutoff Factor (In Inches) (Cont)

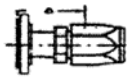
Fitting	Hose Size (Dash No. and/or Letter)											
	Part No.	-3	-4	-5	-6	-8	-10	-12	-16	-20	-24	-32
45 Degree Flareless	MS27630		1.67		2.00	2.31	2.71					
	MS27382	1.23	1.29	1.32	1.43	1.95	1.77	2.23	2.33	2.61	3.03	
	MS27384 (Note 3)	1.23	1.29	1.32	1.43	1.95						
 004t03e	M83798/5											
	(Note 1)	1.20	1.12	1.23	1.36	1.45	1.63	1.93	2.03	2.33		
	(Note 2)	1.13	1.26	1.32	1.42	1.56	1.71	1.90	2.34	2.64	2.98	
	(Note 3)	0.92	0.94	1.05	1.11	1.50	1.71	1.90	2.34	2.64	2.98	

Notes: 1. Cutoff factor for one fitting, Aeroquip.
2. Cutoff factor for one fitting, Stratoflex.
3. Forged elbow.

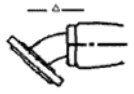
Fitting	Hose Size (Dash No. and/or Letter)											
	Part No.	-3	-4	-5	-6	-8	-10	-12	-16	-20	-24	-32
90 Degree Flareless	MS27631		1.12		1.25	1.44	1.56					
	MS27383	0.86	0.91	0.97	1.03	1.31	1.41	1.92	2.05	2.34	2.68	
	MS27385 (Note 3)	0.86	0.91	0.97	1.03	1.31						
 004t03f	M83798/6											
	(Note 1)	0.89	0.89	0.96	1.07	1.14	1.27	1.63	1.74	2.06		
	(Note 2)	0.79	0.94	0.98	1.07	1.15	1.27	1.59	1.93	2.23	2.47	
	(Note 3)	0.89	0.89	0.96	1.07	1.14						

Notes: 1. Cutoff factor for one fitting, Aeroquip.
2. Cutoff factor for one fitting, Stratoflex.
3. Forged elbow.

Table 6. Hose Cutoff Factor (In Inches) (Cont)

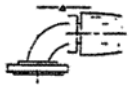
Fitting	Hose Size (Dash No. and/or Letter)										
	Part No.	-8	-10	-12	-16	-20	-24	-32	-40	-48	
Straight Flanged	MS27054	1.27	1.35	1.55	1.61	1.69	1.81				
	MS27232	1.64	1.65	1.67	1.53	1.53	1.46	1.66	1.98	1.98	
	MS18088	0.53	0.53	0.53	0.53	0.56	0.62				
	M83798/7										
004t03g	(Note 1)			1.25	1.30	1.50	1.34	1.52			
	(Note 2)			1.25	1.46	1.67	1.60	1.74			

Notes: 1. Cutoff factor for one fitting, Aeroquip.
2. Cutoff factor for one fitting, Stratoflex.

Fitting	Hose Size (Dash No. and/or Letter)										
	Part No.	-8	-10	-12	-16	-20	-24	-32	-40	-48	
45 Degree Flanged	MS27056	1.25	1.42	1.90	1.98	2.22	2.50				
	MS27230			1.74	1.69	1.96	2.16	2.50	3.04	3.34	
	MS28749	1.44	1.53	1.74	1.69	1.96	2.16	2.51	3.04	3.34	
	MS18089	1.35	1.53	1.97	2.14	2.18	2.53				
	M83798/8										
004t03h	(Note 1)			1.60	1.68	1.93	2.03	2.36			
	(Note 2)			1.57	1.87	2.11	2.29	2.57			

Notes: 1. Cutoff factor for one fitting, Aeroquip.
2. Cutoff factor for one fitting, Stratoflex.

Table 6. Hose Cutoff Factor[1] (In Inches) (Cont)

Fitting	Hose Size (Dash No. and/or Letter)											
	Part No.	-8	-10	-12	-16	-20	-24	-32	-40	-48		
90 Degree Flanged	MS27058	1.21	1.42	1.92	2.05	2.34	2.68					
	MS27228			1.76	1.75	2.09	2.34	2.80	3.42	3.80		
	MS28750	1.39	1.52	1.76	1.75	2.09	2.34	2.80	3.42	3.80		
 004t03i	MS18090	1.18	1.37	2.00	2.25	2.28	2.78					
	M83798/9											
	(Note 1)			1.63	1.74	2.06	2.22	2.65				
	(Note 2)			1.59	1.93	2.23	2.47	2.86				

Notes: 1. Cutoff factor for one fitting, Aeroquip.
2. Cutoff factor for one fitting, Stratoflex.

NOTE

Aeroquip uses letters to designate hose size.

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

FABRICATION

DISASSEMBLY

AIR FORCE USE ONLY

Reference Material

None

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Low Pressure Hose	2
Medium Pressure Hose	2

Record of Applicable Technical Directives

None

1. GENERAL.

2. This work package is for Air Force use only. This section furnishes general and specific guidelines for disassembly of hose assemblies.

3. PROCEDURE.

4. Disassembly procedure for hose assemblies are the reverse of assembly procedures. Refer to the applicable assembly section.

5. Low Pressure Hose. Low pressure hose assembly fittings AN773 and MS27404 may be reused provided serviceability is established. See Section XIV for Cleaning and Section IV for Inspection Criteria. Condemn used hose.

6. Medium Pressure Hose. Medium pressure hose assembly fittings, MIL-F- 27272, MS24587 and 601 Little Gem may be reused provided serviceability is established. See Section XIII for cleaning and Section IV for inspection criteria. Condemn used hose.

7. High Pressure Hose. High pressure hose assembly fittings, MS28760, MS28761, MS28780 and MS28781 shall not be salvaged and reused, nor shall used hose be reused.

8. High Pressure Teflon Hose. High pressure Teflon hose assembly fittings, MIL-F-83296 may be reused provided serviceability is established. See Section XIV for cleaning and Section IV for inspection criteria. Condemn used hose.

a. Place socket in vise, loosen nipple assembly by applying wrench to nipple hex and remove.

b. Cut the hose approximately 1 inch from the socket skirt.

c. With the socket held firmly in a vise, remove the teflon tube from the sleeve and hose reinforcement using needle nose pliers.

d. With the socket still in a vise, insert the disassembly tool MS27639 size so that the shoulder on the tool engages the shoulder in the sleeve. Care shall be taken not to damage the sleeve. Using a hammer, tap the tool until the sleeve separates from the socket and hose reinforcement. The reinforcement can then be pulled out of the socket.

e. Remove hose fitting on opposite end of assembly.

f. All removed hose will be condemned and disposed of in accordance with existing regulations.

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

FABRICATION

LOW AND MEDIUM PRESSURE HOSE ASSEMBLIES

Reference Material

Bulk Hose and Fittings, Description WP003 00
Hose and Hose Assembly, Installation and Maintenance WP005 00
Hose and Hose Assembly, Quality Assurance, Storage, and Age Control WP006 00
Fuel and Hydraulic System Protective Closures, Description WP007 00
Aviation Crew Systems Oxygen Equipment ..... NAVAIR 13-1-6.4 Series
Hose Assemblies, Rubber Hydraulic, Fuel- and Oil-Resistant MIL-DTL-8795
Hose Assembly - Detachable Swivel Fitting, Low-Pressure AN6270

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Fabricating Hose Assemblies AN6270 and MIL-DTL-8795 With Double-Ended Elbow or Flanged Fittings	4
Preparation of Low-Pressure Synthetic Rubber Hose, MIL-DTL-6000 and MIL-DTL-7938	2
Attaching Identification Band	2
Cleaning	2
Measuring	2
Preparation for Installation	2

Record of Applicable Technical Directives

None

1. GENERAL.

2. This Work Package describes the process for constructing low and medium pressure rubber hose assemblies per the following specifications:

Low Pressure Hose Assemblies:

- MIL-DTL-6000
- MIL-DTL-7938
- MIL-DTL-7061
- AN 6270

Medium Pressure Hose Assemblies:

- MIL-DTL-8795

3. Fabricating hose assemblies from bulk hose and reusable end fittings requires some basic skills and a few hand tools. The skills required are the ability to follow step-by-step instructions and the ability to manipulate the hand tools required.

WARNING

When cutting or stripping nylon core and synthetic rubber with a high speed cutting machine, ensure proper ventilation is available and approved by local Occupational Safety and Health.

Use of compressed air can create an environment of propelled particles. Do not direct air streams towards self or other personnel. Air pressure shall be reduced to less than 30 PSIG and used with effective chip guarding and personal protective equipment.

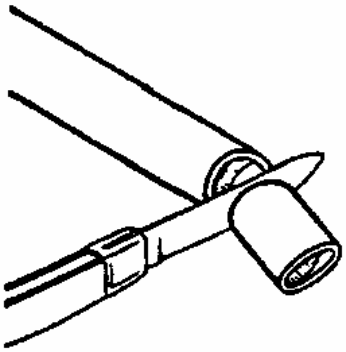
4. PREPARATION OF LOW-PRESSURE SYNTHETIC RUBBER HOSE, MIL-DTL-6000 AND MIL-DTL-7938.

Materials Required

Specification or Part Number	Nomenclature
MIL-DTL-6000	Hose
MIL-DTL-7938	Hose

5. The following steps shall be taken to prepare low-pressure synthetic rubber hose, MIL-DTL-6000 and MIL-DTL-7938.

6. MEASURING. Measure hose to required length and cut off square (Figure 1). Use cutoff machine or a sharp knife.



004003

Figure 1. Hose Cutting

7. CLEANING. Clean hose in accordance with Work Package 004 00.

8. ATTACHING IDENTIFICATION BAND. Attach hose identification band as specified in WP003 00.

9. PREPARATION FOR INSTALLATION OR STORAGE. Prepare hose for installation or storage in accordance with WP005 00 and WP006 00. See Table 3 for performance characteristics.

10. LOW- AND MEDIUM-PRESSURE SYNTHETIC RUBBER HOSE ASSEMBLIES, AN6270 AND MIL-DTL-8795.

Support Equipment Required

Part No. or Type Designation	Nomenclature
S1272-8-1	Socket Preseat Hand Tool

Materials Required

Specification or Part Number	Nomenclature
MIL-DTL-5593	Hose
MIL-DTL-8794	Hose
MIL-PRF-83282	Hydraulic Fluid
MIL-PRF-85570, Type II	Aircraft Exterior Cleaning Compound
MIL-S-45180, Type II	Gasket Sealing Compound

11. Low Pressure AN 6270 Hose Assemblies and Medium Pressure MIL-DTL-8795 Hose Assemblies are constructed with similar instructions. Use hose MIL-DTL-5593 to fabricate low-pressure hose assem-

bly AN6270 (Table 1). Use hose MIL-DTL-8794 to fabricate medium-pressure hose assembly MIL-DTL-8795 (Table 2). See Table 4 for Performance Characteristics.

12. Fabricating Hose Assemblies AN6270 and MIL-DTL-8795 With Single or Double Straight Fittings. To fabricate low- and medium-pressure hose assemblies AN6270 and MIL-DTL-8795 with straight fittings, proceed as follows:

a. Determine hose length from Figure 2 and WP 004 00 Table 6 (WP 004 00, page 16).

b. Wrap circumference of hose with masking or plastic electrical tape at cutoff to prevent flareout of braid if hose outer cover is wire braid. Hose with rubber or fabric outer cover does not require wrapping with tape.

c. Measure hose to required length and cut off square, using cutoff machine. A sharp knife may be used for rubber and fabric hoses.

d. Blow hose clean with filtered shop air after cutting.

CAUTION

Do not over tighten vise on thin-walled, lightweight fittings.

e. Remove tape and clamp socket in vise (Figure 2). Screw hose counterclockwise into socket, using a twisting, pushing motion until hose bottoms on socket shoulder.

f. Back out hose 1/4 turn.

g. Assemble nipple and nut with a standard adapter of the same size and thread (Figure 3).

Hydraulic Fluid, MIL-PRF-83282 **1**

Hydraulic Fluid, MIL-H-81019 **2**

h. Lubricate inside bore of hose and outside surface of nipple with hydraulic fluid, MIL-PRF-83282 or MIL-H-81019 (Figure 4).

i. Clamp socket with hose into vise. Insert nipple assembly into hose and socket, using a wrench on the hex of the insertion tool.

j. Turn nipple assembly clockwise until nut to socket gap is between .005 and .031 inches. The gap shall allow nut to turn freely about its axis (Figure 5).

k. Remove insertion tool from assembly.

NOTE

Repeat steps e through k for hose assembly with straight fittings on both ends.

l. Clean, inspect, test, identify, and prepare for installation or storage in accordance with WP003 00 thru WP006 00.

13. Fabricating Hose Assemblies AN6270 and MIL-DTL-8795 With Single Elbow or Single-Flanged Elbow Fittings. To fabricate low- and medium-pressure hose assemblies AN6270 and MIL-DTL-8795 with elbow or flanged elbow fittings, proceed as follows:

NOTE

The AN or MS type elbow (45 or 90 degree) has a nipple and swivel nut assembled.

a. Determine the hose length from Figure 2 and WP 004 00 Table 6 (WP 004 00, page 16).

b. Wrap circumference of hose with masking or plastic electrical tape at cutoff to prevent flareout of braid if hose outer cover is wire braid. Hose with rubber or fabric outer cover does not require wrapping with tape.

c. Measure hose to required length and cut off square. Use hose cutoff machine. A sharp knife may be used for rubber and fabric type hoses.

d. Blow hose clean with filtered shop air after cutting.

CAUTION

Do not overtighten vise on thin-walled, lightweight fittings.

e. Remove tape and clamp socket in vise (Figure 2). Screw hose counterclockwise into socket using a twisting, pushing motion until hose bottoms on socket shoulder.

f. Back out hose 1/4 turn.

g. For flange elbow fittings, place flange over threaded end of nipple (Figure 6). Nipple shoulder shall fit into counterbore of flange.

Hydraulic Fluid, MIL-PRF-83282 1

h. Lubricate inside bore of hose and outside surface of nipple with hydraulic fluid, MIL-PRF-83282 (Figure 4).

i. Clamp socket with hose into vise.

j. Adjust socket and elbow clearance.

(1) On fittings less than two inches in diameter:

(a) Screw nipple assembly into hose.

(b) Using a wrench on elbow hex (Figure 7), turn elbow clockwise until elbow hex is within 1/16 inch of socket.

(2) On fittings two inches in diameter or larger:

(a) Screw nipple assembly into hose.

(b) Using a wrench on elbow hex (Figure 7), turn elbow clockwise until elbow becomes difficult to turn.

(c) Back out nipple assembly and lubricate as described in step (h).

(d) Using a wrench on elbow hex (Figure 7), turn elbow clockwise until elbow hex is within 1/16 inch of the socket.

14. Fabricating Hose Assemblies AN6270 or MIL-DTL-8795 With Straight Fitting on One End and Elbow or Flanged Elbow Fitting on Other End. Paragraphs 12 and 13 provide instructions for a complete hose assembly AN6270 or MIL-DTL-8795, consisting of one straight end fitting and one elbow or flanged elbow end fitting.

15. Fabricating Hose Assemblies AN6270 or MIL-DTL-8795 With Double-Ended Elbow or Flanged Elbow Fittings. To fabricate a double-ended elbow or a flanged elbow assembly, repeat instructions in Paragraph 13 for one end and continue with the following steps:

Do not over tighten vise on thin-walled, lightweight fittings.

a. Remove tape and clamp socket in vise (Figure 2). Screw hose counterclockwise into socket, using a twisting, pushing motion until hose bottoms on socket shoulder.

b. Back out hose 1/4 turn.

c. For flange elbow fittings, place flange over threaded end of nipple (Figure 6). Nipple shoulder shall fit into counterbore of flange.

Hydraulic Fluid, MIL-PRF-83282 1

d. Lubricate inside bore of hose and outside surface of nipple with hydraulic fluid, MIL-PRF-83282 (Figure 4).

e. Clamp socket with hose in vise so opposite end fitting points downward. Make sure hose does not have an axial twist.

f. Insert nipple assembly into hose and socket.

g. Using a wrench on elbow hex, turn nipple assembly clockwise until elbow hex is within 1/16 inch of the socket.

h. Rotate elbow to required angular position as shown in Figures 8 through 13.

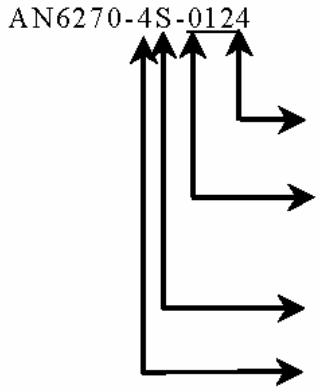
NOTE

Adjust both elbows to get correct relative angle between the two ends. Except for alignment, backing off for position shall be avoided. If backing off for position is necessary, do not exceed one quarter turn.

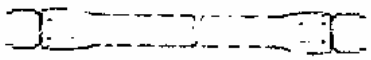
i. Clean, inspect, test, identify and prepare hose assembly for installation or storage in accordance with WP003 00 thru WP006 00.

Table 1. Synthetic Rubber Low-Pressure Hose Assembly Per AN6270

Example of Part No.:



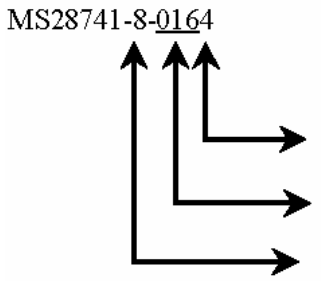
004t01a

Flared to Flared		Hose Assembly Part No.	Dash Size (Note 1)	Fittings	
A	B			A	B
 004t01b		AN6270	-2 thru -10	MS27404	MS27404

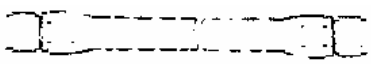
Notes: 1. Add D after dash no. for aluminum alloy end fitting. Add S after dash no. for steel end fitting.

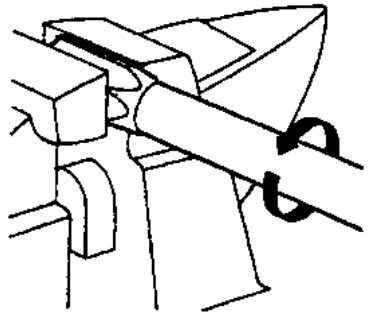
Table 2. Synthetic Rubber Medium-Pressure Hose Assembly Per MIL-DTL-8795

Example of Part No.:



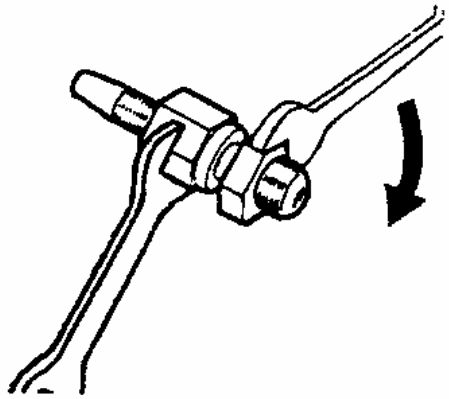
004t02a

Flared to Flared		Hose Assembly Part No.	Dash Size	Fittings	
A	B			A	B
 004t02b		MS28741	-3 thru -32	MS24587	MS24587



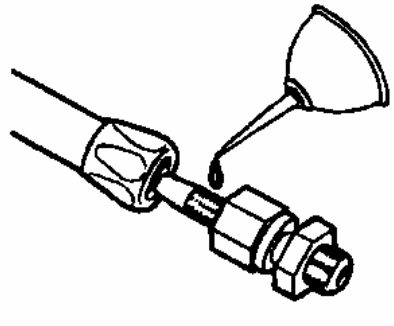
004005

Figure 2. Low- and Medium-Pressure Hose Insertion



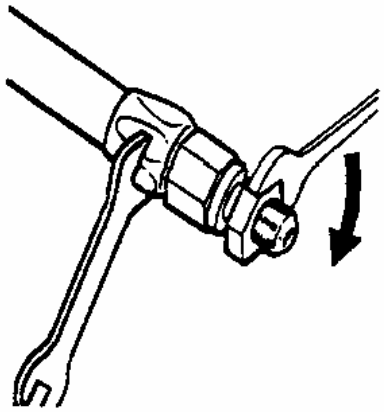
004006

Figure 3. Nipple and Nut Assembly



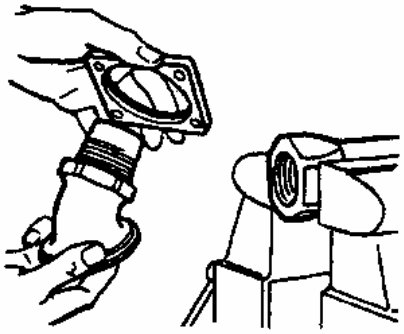
004007

Figure 4. Low- and Medium-Pressure Hose Assembly Lubrication



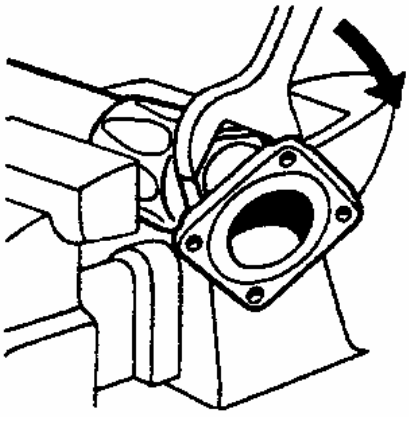
004008

Figure 5. Nipple Assembly Adjustment



004009

Figure 6. Flange Assembly



004010

Figure 7. Low- and Medium-Pressure Hose Nipple Assembly

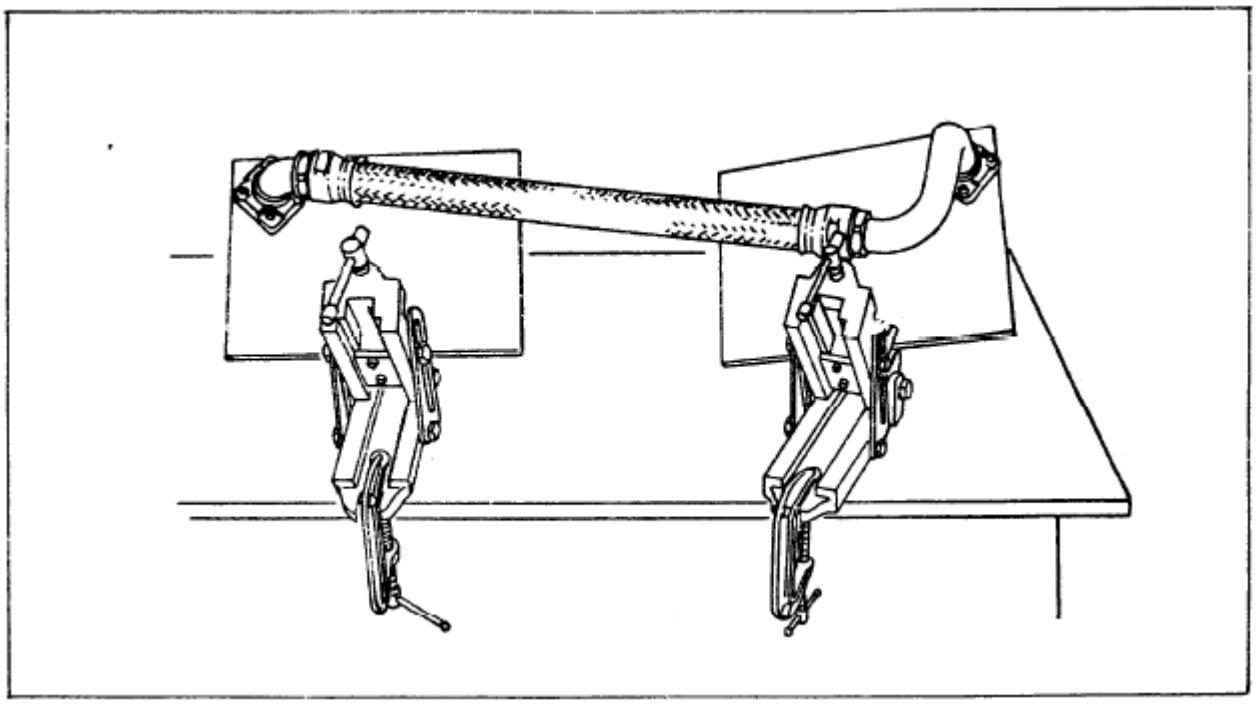


Figure 8: Measuring Device

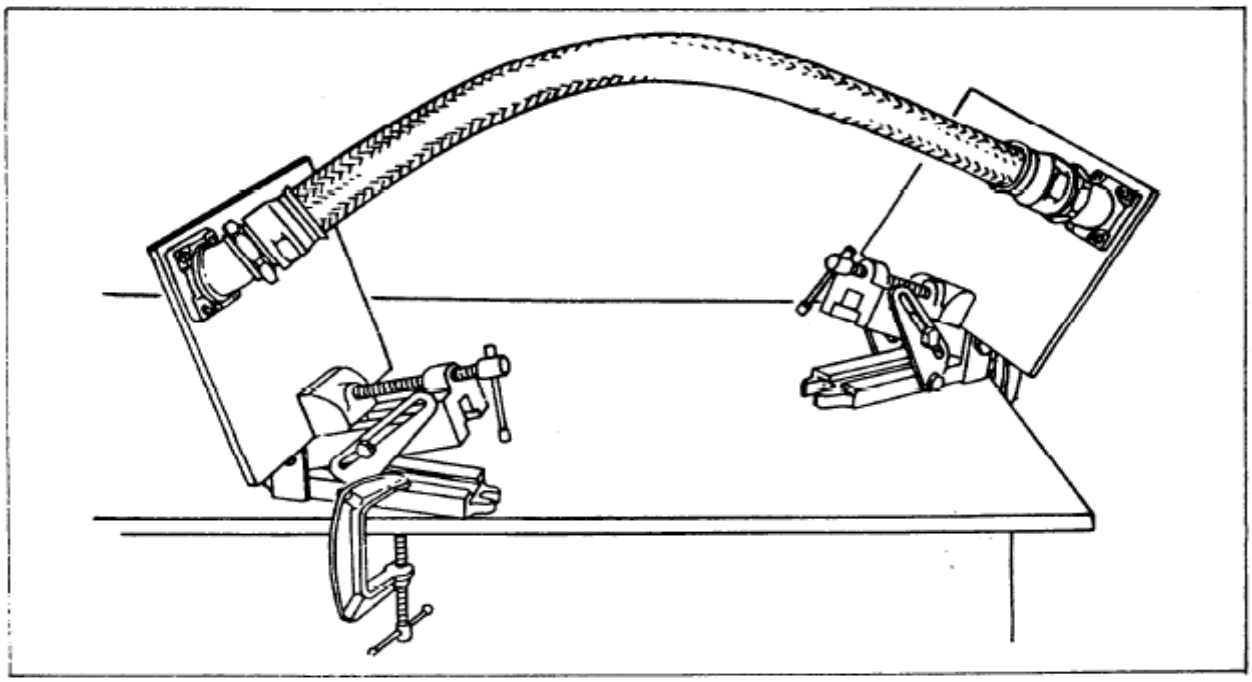


Figure 9: Positioning

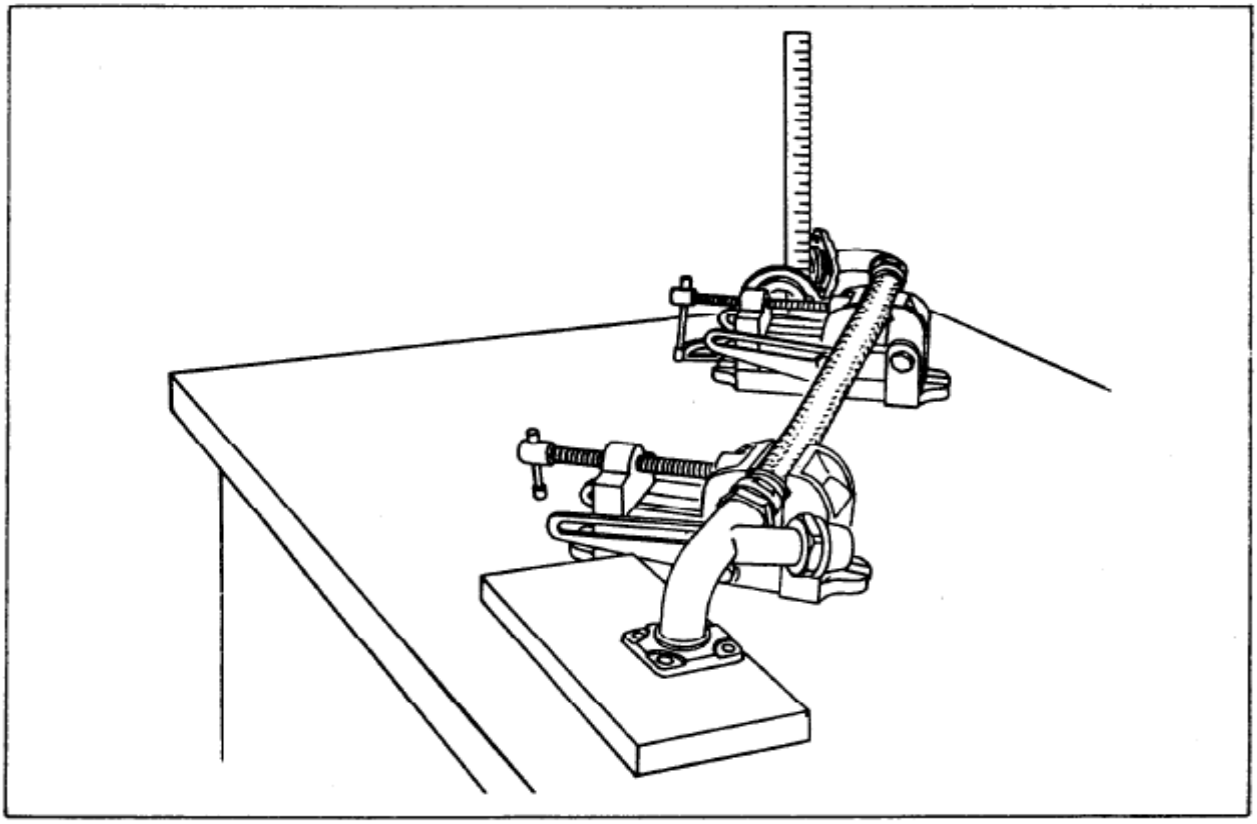


Figure 10: Positioning

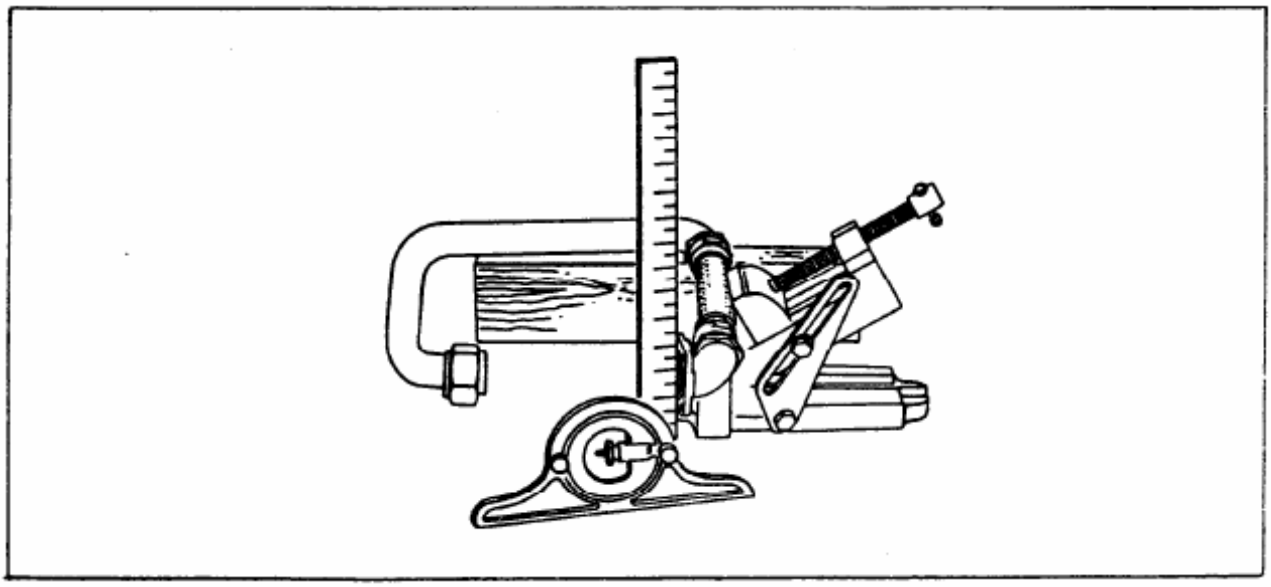


Figure 11: Angle Setting, Protractors

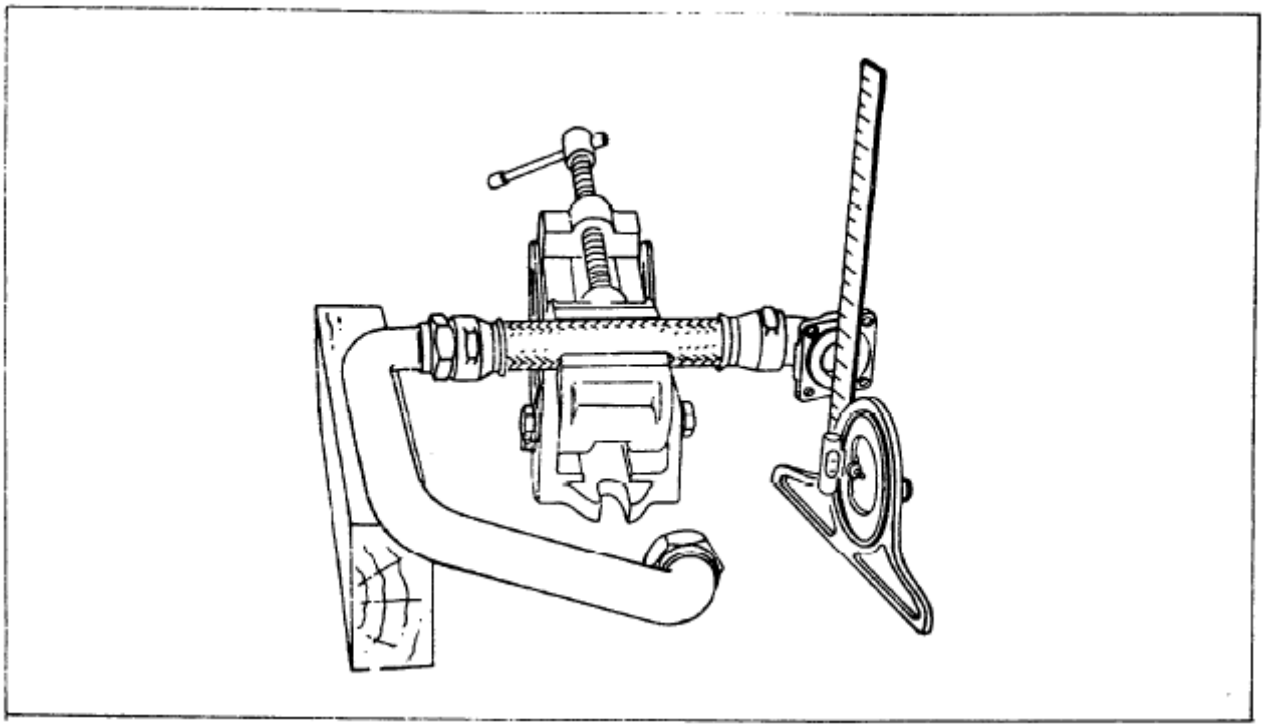


Figure 12: Angle Settings

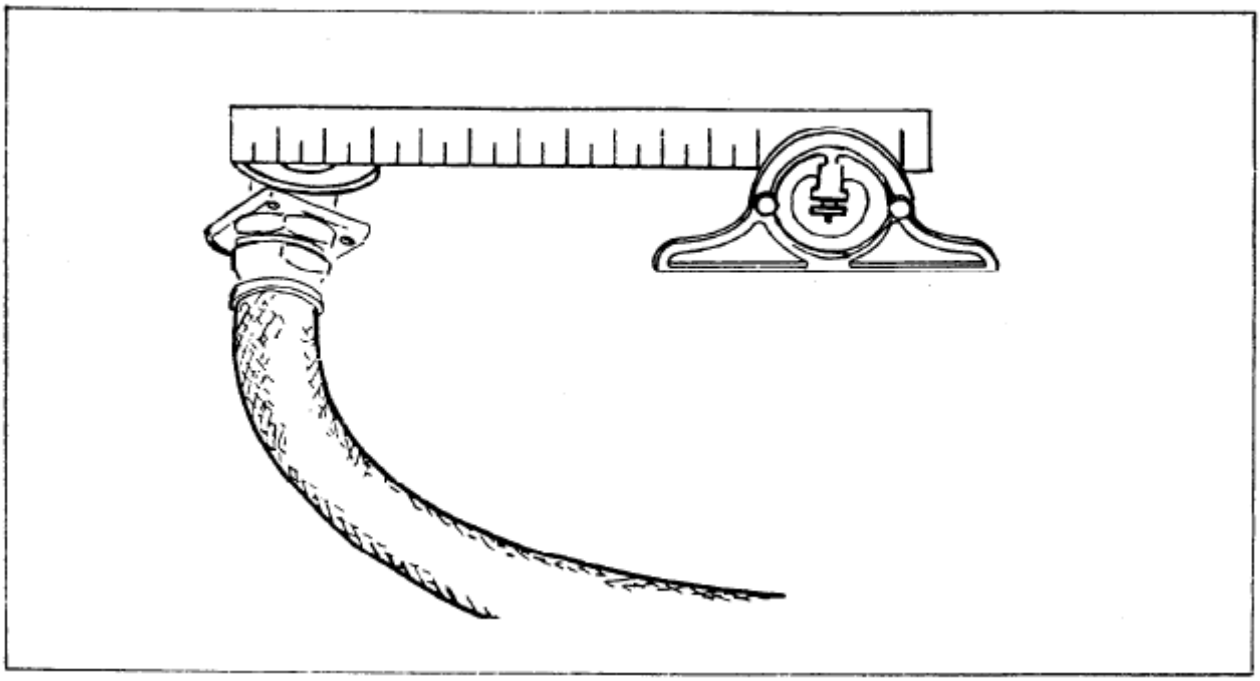


Figure 13: Angle Settings

Table 3: Performance Characteristics of MIL-DTL-6000 Low Pressure Rubber Hose

	Inside Diameter (ID)					
Test Condition (Note 1)	**¼ to 1 ¼ inch**	**1 ¼ to 1 ½ inch**	**1 ¾ to 2 inches**	**2 ½ to 3 inches**	**3 ½ inches**	**4 inches**
Operating Pressure (Note 2) (psi max)	250	200	150	100	90	75
Proof Pressure (Note 3) (psi min)	500	400	300	200	175	150
Burst Pressure (Note 3) (psi min)	1000	800	600	400	350	300
Minimum Bend Radius	12 times the Inside Diameter (ID)					

Note 1: Typical operating pressures and burst pressures are included for information purposes only.
Note 2: Pressures are maximum (psi max)
Note 3: Pressures are minimum (psi min)

Table 4: Performance Characteristics of AN6270 Low Pressure Rubber Hose

Test Condition (Note 1)	**-2**	**-3**	**-4**	**-6**	**-8**	**-10**
Operating Pressure (Note 2) (psi max)	300	250	200	150	150	150
Proof Pressure (Note 3) (psi min)	600	500	400	300	250	250
Burst Pressure (Note 3) (psi min)	2000	1700	1250	1000	750	700
Minimum Bend Radius (inches)	2.00	2.00	4.00	4.00	6.00	6.00

Note 1: Typical operating pressures and burst pressures are included for information purposes only.
Note 2: Pressures are maximum (psi max)
Note 3: Pressures are minimum (psi min)

Table 5: Performance Characteristics of MIL-DTL-8794 Medium Pressure Rubber Hose

Operating Fluid	Test Condition (Note 1)	-3	-4	-5	-6	-8	-10
Hydraulic	Operating Pressure (Note 2)	2000	3000	3000	2000	2000	1750
	Proof Pressure (Note 3)	4000	6000	5000	4500	4000	3500
	Burst Pressure (Note 3)	8000	12000	10000	9000	8000	7000
Fuel	Operating Pressure (Note 2)	1000	1000	1000	1000	1000	1000
	Proof Pressure (Note 3)	1500	1500	1500	1500	1500	1500
	Burst Pressure (Note 3)	8000	12000	10000	9000	8000	7000
Oil	Operating Pressure (Note 2)	50	50	50	50	50	50
	Proof Pressure (Note 3)	600	600	600	600	600	600
	Burst Pressure (Note 3)	8000	12000	10000	9000	8000	7000
Minimum Bend Radius (inches)		3.00	3.00	3.38	4.00	4.62	5.50

Operating Fluid	Test Condition (Note 1)	-12	-16	-20	-24	-32	-40	-48
Hydraulic	Operating Pressure (Note 2)	1500	800	600	500	350	-	-
	Proof Pressure (Note 3)	3000	1600	1250	1000	700	-	-
	Burst Pressure (Note 3)	6000	3200	2500	2000	1400	-	-
Fuel	Operating Pressure (Note 2)	1000	750	500	250	200	200	200
	Proof Pressure (Note 3)	1500	1000	750	375	300	300	300
	Burst Pressure (Note 3)	6000	3200	2500	2000	1400	1000	800
Oil	Operating Pressure (Note 2)	50	50	50	50	50	-	-
	Proof Pressure (Note 3)	600	600	600	600	600	-	-
	Burst Pressure (Note 3)	6000	3200	2500	2000	1400	-	-
Minimum Bend Radius (inches)		6.50	7.38	9.00	11.00	13.25	24.00	33.00

Note 1: Typical operating pressures and burst pressures are included for information purposes only.
Note 2: Pressures are maximum (psi max)
Note 3: Pressures are minimum (psi min)

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

FABRICATION

MEDIUM PRESSURE, LIGHT WEIGHT HOSE ASSEMBLIES

Reference Material

Hoses, Hose Assemblies, and Fittings, Description WP003 00
Hose and Hose Assembly, Maintenance WP005 00
Hose and Hose Assembly, Quality Assurance WP006 00
Hose Assembly, Rubber, Lightweight, Medium-Pressure, General Specification for MIL-DTL-83796

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Fabrication of Hose Assemblies With Single Elbow or Single-Flanged Elbow Fittings	6
Fabrication of Hose Assemblies With Straight Fitting on One End and Elbow or Flanged Elbow Fitting on the Other End	7
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Machine Assembly Method for Aeroquip 601 Hose Assemblies **(Air Force Only)**	9
Fire Sleeve (AF)	9
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Marking	9
Medium-Pressure Light-Weight Synthetic Rubber Hose Assemblies MIL-DTL-83796	2
Part Number Interpretation – 601 Hose Assemblies	2

Record of Applicable Technical Directives

None

1. GENERAL.

2. This Work Package describes the process for constructing medium pressure, light weight rubber hose assemblies per the following specifications:

- MIL-DTL-83796
- Aeroquip 601
- Stratoflex 156

3. Fabricating hose assemblies from bulk hose and reusable end fittings requires some basic skills and a few hand tools. The skills required are the ability to follow step-by-step instructions and the ability to manipulate the hand tools required.

WARNING

When cutting or stripping nylon core and synthetic rubber with a high speed cutting machine, ensure proper ventilation is available and approved by local Occupational Safety and Health.

Use of compressed air can create an environment of propelled particles. Do not direct air streams towards self or other personnel. Air pressure shall be reduced to less than 30 PSIG and used with effective chip guarding and personal protective equipment.

4. MEDIUM-PRESSURE LIGHT-WEIGHT SYNTHETIC RUBBER HOSE ASSEMBLIES MIL-DTL-83796. Hose assemblies MIL-DTL-83796 (Table 5) are fabricated with bulk hose MIL-DTL-83797 and fittings supplied by various manufacturers. Fittings manufactured by Aeroquip (00624) and Deutsch (14798) have the same fabrication procedures. Fittings manufactured by Stratoflex (98441) with different cutoff factors have different fabrication procedures. Differences are indicated in the step-by-step instructions below. See Table 6 for Performance Characteristics including proof pressure and bend radius data.

5. Part Number Interpretation – 601 Hose Assemblies. Aeroquip 601 hose assemblies conform to specification MIL-DTL-83796 and may be identified as follows:

a. Hose assemblies with straight fitting or elbow on one side only, Table 1.

Table 1. Aeroquip 601 Hose Assembly Identification

Hose assembly part number	Hose size	Fitting material	Assembly Length Inches - 1/8 inches
601001	8	D	021 4

Position angle	Hose assembly part number	Hose size	Assembly Length Inches - 1/8 inches
035	601017	J	021 4

b. Hose assembly with elbow fitting on each end:

(1) A relative position angle 0º is specified 000. In all cases, angle is expressed in 3 digits.

(2) Elevation view (Figure 1) shows right end of hose assembly placed in front and in the vertical plane and the left end placed behind it.

c. Hose size (ID) is expressed alphabetically, Table 2.

Table 2. Aeroquip Hose Size Identification

Dash Size	2	3	4	5	6	8	10
Letter Code	A	E	F	G	H	J	K

Dash Size	12	16	20	24	32	40	48
Letter Code	L	M	N	P	R	T	U

6. HAND ASSEMBLY METHOD

7. Hand assembly method for MIL-DTL-83796, Aeroquip 601, and Stratoflex 156 hose assemblies are as follows. For Aeroquip 601 machine assisted assembly method, refer to paragraph 12.

8. Fabrication of Hose Assemblies With Single or Double Straight Fittings. To fabricate medium pressure hose assemblies MIL-DTL-83796 (Table 5) with straight fittings, proceed as follows:

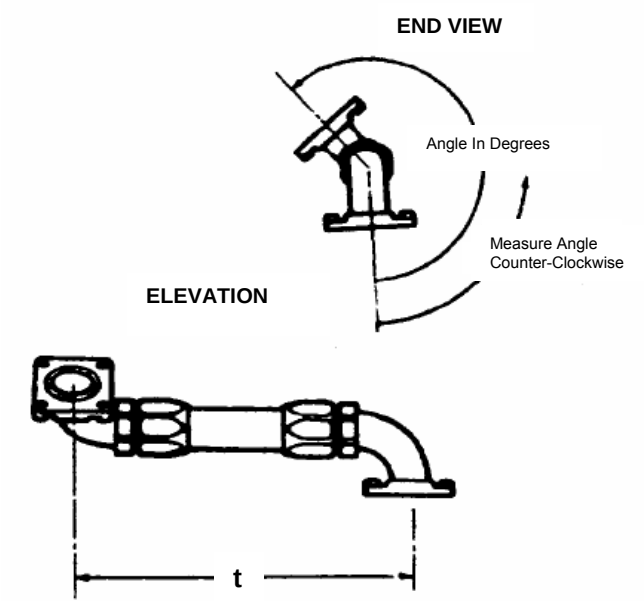


Figure 1. Elevation View Hose Assembly

a. Determine hose length from WP 004 00: Figure 7 and Table 6.

b. Wrap hose circumference with masking or plastic electrical tape at cutoff to prevent flareout of wire braid.

c. Measure hose to required length and cut off square, using cutoff machine.

d. Blow hose clean with filtered shop air after cutting.

e. Remove tape after cutting hose.

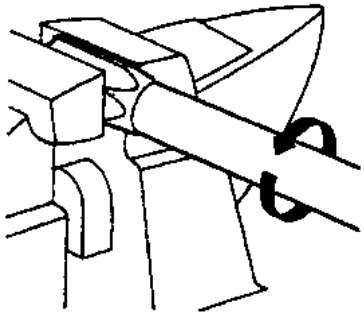
CAUTION

Do not overtighten vise on thin-walled, lightweight fittings.

f. Clamp socket in vise.

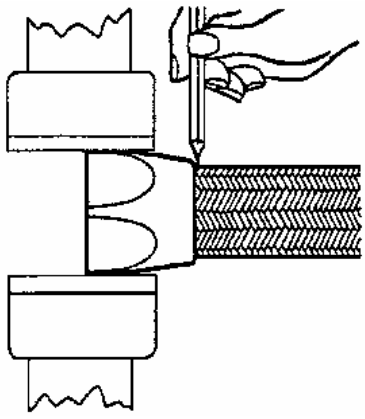
g. Insert hose into socket, using a twisting, pushing motion until hose bottoms out against socket threads. (Figure 2)

h. Mark hose position around hose at rear of socket with a grease pencil, painted line, or tape (Figure 3).



004005

Figure 2. Low- and Medium-Pressure Hose Insertion



004012

Figure 3. Marking Hose

Hydraulic Fluid, MIL-PRF-83282 **1**

NOTE

Replace O-ring when installing Stratoflex fittings.

i. Assemble O-ring, sleeve, and nipple (Figures 4 and 5).

(1) For Stratoflex fittings, install O-ring seal on nipple. Install sleeve on nipple with sleeve touching O-ring.

(2) Aeroquip and Deutsch fittings do not require O-ring assembly.

j. Lubricate hose and hose fitting with hydraulic fluid MIL-PRF-83282 (Figure 6).

(1) On Stratoflex fittings, lubricate inside bore of hose, socket threads, O-ring, and outside diameter of sleeve.

(2) On Aeroquip and Deutsch fittings, lubricate inside bore of hose and nipple threads.

k. Insert nipple into socket. Engage threads by turning nipple clockwise and pressing firmly while holding the hose with one hand (Figure 8).

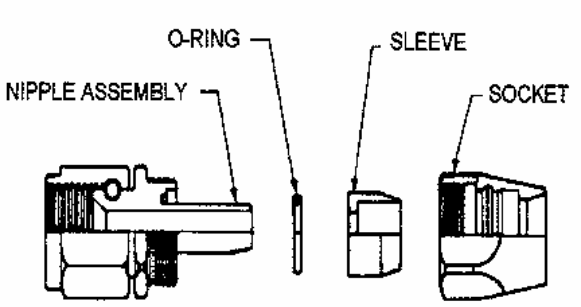
l. Check for hose backout by observing the hose position mark made in step (h). Make sure hose does not back out of socket.

m. Turn nipple clockwise with wrench on nipple hex while holding hose in place with other hand (Figure 9).

n. Check for allowable gap between nipple and socket hexes.

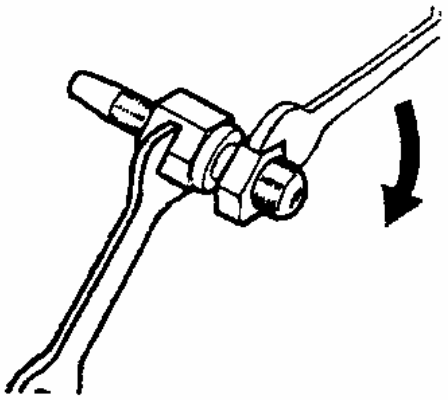
(1) For Stratoflex fittings, the maximum allowable gap between nipple hex and socket is between .015 and .060 inch.

(2) For Aeroquip and Deutsch fittings, the maximum allowable gap between nipple hex and socket hex is .041 inch for sizes -3, -4, -5 and .031 inch for sizes -6 and up.



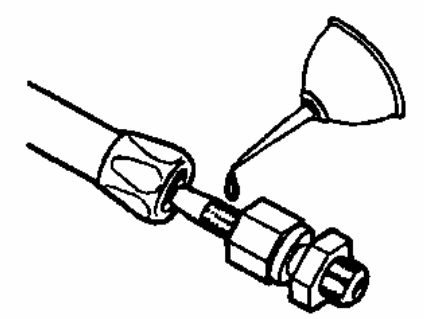
004013

Figure 4. Stratoflex Fitting



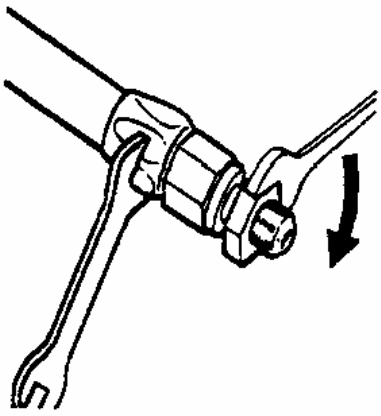
004006

Figure 5. Nipple and Nut Assembly



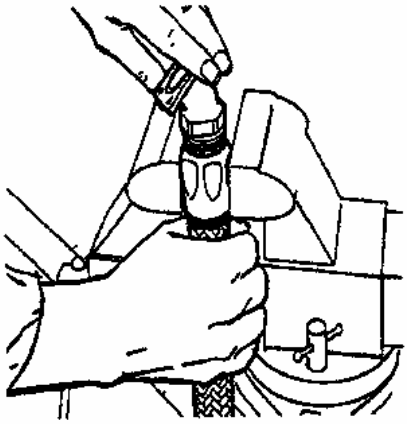
004007

Figure 6. Low- and Medium-Pressure Hose Assembly Lubrication



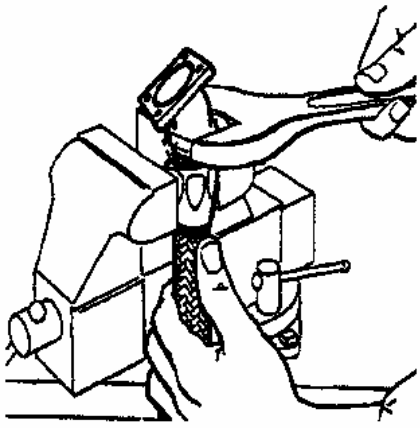
004008

Figure 7. Nipple Assembly Adjustment



004014

Figure 8. Medium-Pressure



004015

Figure 9. Medium-Pressure Lightweight Hose Nipple Assembly Lightweight Hose Tightening Assembly

o. Check for hose backout by observing the hose position mark. If hose backout does not meet the requirements in the following sub-steps, disassemble fitting and repeat steps f through o.

(1) On Stratoflex fittings, allowable hose backout is .030 inch for sizes -4 through -10 and .050 inch for sizes -12 and above.

(2) On Aeroquip and Deutsch fittings, no backout is allowed.

NOTE

For hose assembly MIL-DTL-83796 with straight fittings on both ends, repeat steps f through o on other end of hose.

p. Clean, test, inspect, identify, and prepare hose assembly for installation or storage per WP003 thru WP006.

9. Fabrication of Hose Assemblies With Single Elbow or Single-Flanged Elbow Fittings. To fabricate medium-pressure hose assemblies MIL-DTL-83796 with elbow or flanged elbow fittings (Table 5), proceed as follows:

a. Determine hose length from WP 004 00: Figure 7 and Table 6.

b. Wrap hose circumference with masking or plastic electrical tape at cutoff to prevent flareout of wire braid.

c. Measure hose to required length and cut off square, using hose cutoff machine.

d. Blow hose clean with filtered shop air after cutting.

e. Remove tape after cutting hose.

CAUTION

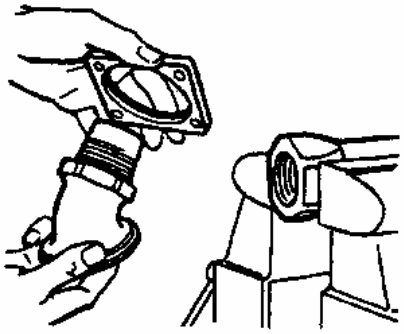
Do not overtighten vise on thin-walled fittings.

f. Clamp socket in vise.

g. Insert hose in socket, using a twisting, pushing motion until hose bottoms against socket threads.

h. Mark hose position around hose at rear of socket with a grease pencil, painted line, or tape (Figure 3).

i. For a flanged elbow, place flange over threaded end of elbow. Nipple shoulder must fit into counterbore of flange (Figure 10).



004009

Figure 10. Flange Assembly

Hydraulic Fluid, MIL-PRF-83282 **1**

Hydraulic Fluid, MIL-H-81019 **2**

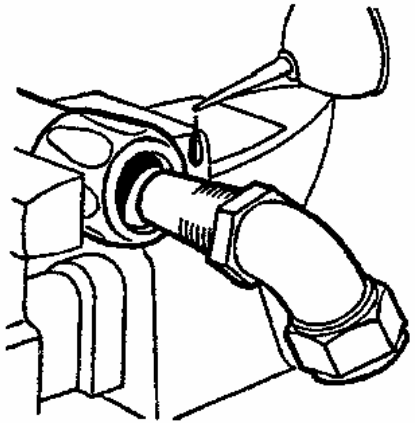
NOTE

Replace O-ring when installing Stratoflex fittings.

j. Lubricate hose and hose fittings with hydraulic fluid MIL-PRF-83282.

(1) On Stratoflex fitting, lubricate inside bore of hose and outside diameter of sleeve.

(2) On Aeroquip and Deutsch fittings, lubricate inside bore of hose and nipple threads (Figure 11).



004016

Figure 11. Assembly Lubrication for Aeroquip and Deutsch Fittings

k. Assemble O-ring, sleeve, and nipple (Figure 4).

(1) For Stratoflex fittings, install O-ring seal on nipple. Install sleeve on nipple with sleeve touching O-ring.

(2) Aeroquip and Deutsch fittings do not require O-ring assembly.

l. Insert nipple into socket. Engage thread by turning nipple clockwise and pressing firmly while holding hose with one hand (Figure 8).

m. Check hose backout by observing the position mark made in step (h). Make sure hose does not back out of socket.

n. Turn elbow clockwise with wrench on elbow hex while holding hose in place with one hand. (Figure 9)

(1) For Stratoflex fittings, the maximum allowable gap between nipple hex and socket is .060 inch.

(2) For Aeroquip and Deutsch fittings, tighten nipple until hex is snug against socket.

o. Check for hose backout by observing the hose position mark. If hose backout does not meet the requirements as described in the following substeps, repeat steps f through o.

(1) For Stratoflex fittings, allowable hose backout is .030 inch for sizes -4 through -10 and .050 inch for sizes -12 and above.

(2) For Aeroquip and Deutsch fittings, no backout is allowed.

10. Fabrication of Hose Assemblies With Straight Fitting on One End and Elbow or Flanged Elbow Fitting on the Other End. Paragraphs 8 and 9 provide instructions for a complete hose assembly MIL-DTL-83796, consisting of one straight end fitting and one elbow or flanged elbow end fitting.

11. Fabrication of Hose Assemblies With Double-Ended Elbow or Flanged Elbow Fittings. To fabricate a double-ended elbow or a flanged elbow assembly, repeat instructions in Paragraph 9 for one end and continue with the following steps:

Do not overtighten vise on thin-walled, lightweight fittings.

a. Clamp socket in vise.

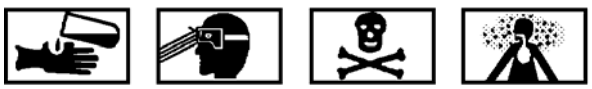
b. Insert hose into socket using a twisting, pushing motion until hose bottoms against socket threads.

c. Mark hose position around hose at rear of socket with a grease pencil, painted line, or tape (Figure 3).

d. Without twisting hose, reposition socket with hose into vise so the opposite assembled fitting points downward.

e. For a flanged elbow, place flange over threaded end of elbow. Nipple shoulder must fit into counterbore of flange (Figure 10).

Hydraulic Fluid, MIL-PRF-83282 **1**



Hydraulic Fluid, MIL-H-81019 **2**

NOTE

Replace O-ring when installing Stratoflex fittings.

f. Lubricate hose and hose fitting with hydraulic fluid MIL-DTL-83282.

(1) On Stratoflex fittings, lubricate inside bore of hose and outside diameter of sleeve.

(2) For Aeroquip and Deutsch fittings, lubricate inside bore of hose and nipple threads (Figure 11).

g. Assemble O-ring, sleeve, and nipple (Figure 4).

(1) For Stratoflex fittings, install O-ring seal on nipple. Install sleeve on nipple with sleeve touching O-ring.

(2) Aeroquip and Deutsch fittings do not require O-ring assembly.

h. Insert nipple into socket. Engage thread by turning nipple clockwise and pressing firmly while holding the hose with one hand (Figure 8).

i. Check for hose backout by observing the position mark made in step (c). Make sure hose does not back out of socket.

j. Turn elbow clockwise with wrench on elbow hex while holding hose in position with the other hand.

(1) On Stratoflex fittings, the allowable gap between nipple hex and socket is .015 to .060 inch.

(2) On Aeroquip and Deutsch fittings, tighten both elbows to within 1/32 inch of sockets.

k. Check for hose backout by observing the hose position mark. If hose backout does not meet requirements as described in the following substeps, disassemble fitting and repeat steps a through k.

(1) For Stratoflex fittings, allowable hose backout is .030 inch for sizes -4 through -10 and .050 for sizes -12 and above.

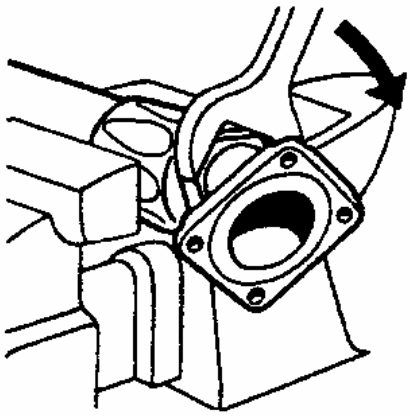
(2) For Aeroquip and Deutsch fittings, no backout is allowed.

l. Position both fittings to obtain required relative angle between each other (Figures 12 and 13).

(1) On Stratoflex fittings, do not backout elbow or flanged elbow to obtain relative angle. Backout can damage O-ring seal and cause assembly to leak. Minimum gap between nipple and hex is .015 inch.

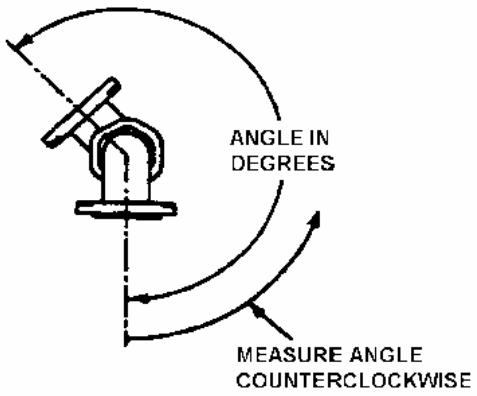
(2) On Aeroquip and Deutsch fittings, adjustments may be necessary to obtain desired position between elbows, however, backing out to obtain relative angle should be avoided. If backing out is necessary for alignment, do not exceed 1/4 turn. Maximum gap between hex and socket is 1/32 inch.

m. Clean, inspect, test, identify and prepare hose assembly for installation or storage in accordance with WP003 00 thru WP006 00.



004010

Figure 12. Low- and Medium-Pressure Hose Nipple Assembly



004011

Figure 13. Angular Positioning

12. (AIR FORCE ONLY) MACHINE ASSEMBLY METHOD FOR AEROQUIP 601 HOSE ASSEMBLIES

13. (AF) Tools And Equipment Required.

a. Hose Cut-Off Machine

b. Hose Cutting and Skiving Machine

c. Hose Assembly Machine, Model F2152.

WARNING

Use of compressed air can create an environment of propelled particles. Do not direct air streams towards self or other personnel. Air pressure shall be reduced to less than 30 PSIG and used with effective chip guarding and personal protective equipment.

14. (AF) Machine Tool Assembly Procedure, F2152. The following procedure is applicable to hose assembly machine, Model F2152 only.

a. **(AF)** Cut the hose the required length with the hose cut-off machine. Assemble socket to hose.

b. **(AF)** Select the correct size mandrel from Table 3 and chuck jaws from Table 4. Place the mandrel onto the mandrel stud until it bottoms, then back off 1/2 turn or more.

c. **(AF)** Install jaws in chuck. Place fitting in the chuck jaws to provide a slip clearance of 1/64 inch at the fitting.

d. **(AF)** Check hose and socket for proper assembly and see that no wire protrudes into the threaded portion of the socket.

NOTE

Mark the hose immediately behind the socket, using paint, tape or a grease pencil. This mark facilitates checking for hose push-out during assembly or testing (Figure 3).

e. **(AF)** Load the hose and socket in the carriage vise with the socket protruding 1/8 to 1/4 inch from the vise.

f. **(AF)** Lubricate the nipple thread and hose bore with SAE 30 oil (Figure 6).

CAUTION

Be careful to avoid getting oil in the cutting spur of the nipple.

g. **(AF)** Move the carriage vise forward to the point of contact with the nipple. Apply a pushing pressure on the hose while moving the carriage forward until the nipple and socket are securely engaged. Maintain pressure on carriage lever during assembly. The pushing pressure on the hose prevents push-out of the hose during initial cutting of the nipple spur.

h. **(AF)** Operate machine until a gap of approximately 1/16 inch is attained, then turn machine off and let coast to 1/32 inch maximum gap.

i. **(AF)** Retract the carriage and remove the hose assembly from carriage vise. To disassemble, reverse the above procedure.

j. **(AF)** Assembly procedure is the same as that described for straight swivel hexed fittings. Select correct size pot chuck pads from Table 4.

k. **(AF)** Install elbow fitting in chuck pads. Pushing pressure must be applied to the hose during initial cutting of the nipple spur. Disassembly procedure is the same as that of the straight swivel hexed fittings.

l. **(AF)** Clean with compressed air.

m. **(AF)** Inspect and proof test per WP 005 and WP 006.

15. MARKING

16. After proof-testing, the hose assembly shall be identified in accordance with WP 004 00.

17. FIRE SLEEVES

18. Install fire sleeve in accordance with WP 004 00 if required.

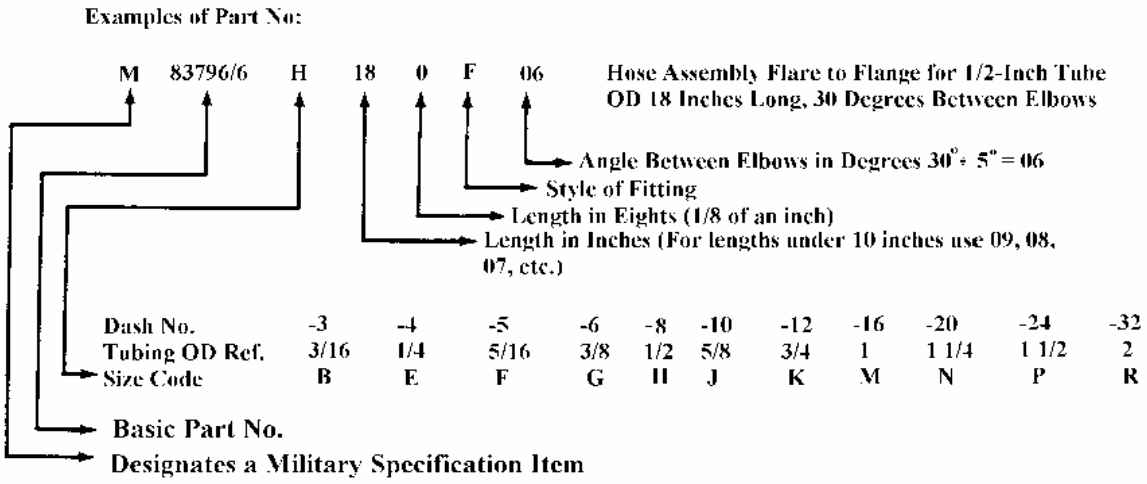
Table 3: Assembly Mandrels for Hose Fittings with Hex on Nipple.

FITTING	MANDRELS	DIAMETER
816-4	F2065-4E	0.149
816-5	F2065-5D	0.210
816-6	F2065-6C	0.273
816-8	F2065-8E	0.365
816-10	F2065-10D	0.471
816-12	F2065-12B	0.575
816-16	F2065-16C	0.780
816-20	F2065-20C	1.025
816-24	F2065-24B	1.263

Table 4: Pot Chuck Pads – for Assembly of Hose Fittings.

FITTING TYPE	NUT HEX SIZES	PAD PART NO.
Straight Fittings	7/16 through 15/16 in.	F-2152-1A
	1 through 2-1/16 in.	F-2152-2A
	2-1/8 through 3 in.	F-2152-3A
ELBOW HEX SIZES		
Standard Elbow Fittings	3/8 through 1 in.	F-2152-4A
	1-3/8 through 1-1/2 in.	F-2152-6A
	1-9/16 through 1-3/4 in.	F-2152-7A
	2-1/8 through 2-5/16 in.	F-2152-8A
	2 through 2-1/8 in.	F-2152-11A
	1-1/16 through 1-1/4 in.	F-2152-12A
	1-9/32 through 1-3/8 in.	F-2152-13A
Special – 24 Elbows - 32	1-1/2 in. Flats	F-2152-9A
	2 in. square	F-2152-10A

Table 5. Synthetic Rubber Medium-Pressure Hose Assembly Per MIL-DTL-83796



004t04a

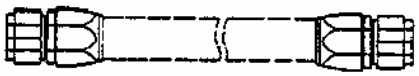
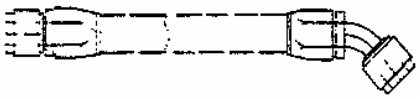
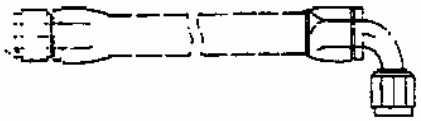
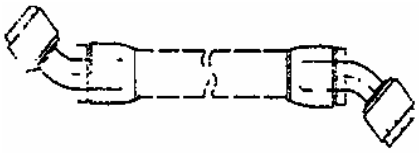
Flared to Flared		Hose Assembly Part No. (Note 2)	Dash Size (Note 3)	Fittings	
A	B			A	B
Style A - Straight to Straight  004t04b Style B - same as Style A but with fire sleeve		M83796/1 or M83796/2 (Note 1)	-3 to -32	MS87018 or M83798/1	MS87018 or M83798/1
Style C - Straight to 45 Degrees  004t04c Style D - same as Style C but with fire sleeve		M83796/1 or M83796/2 (Note 1)	-3 to -32	MS87018 or M83798/1	MS87019 or M83798/2
Style E - Straight to 90 Degrees  004t04d Style F - same as Style E but with fire sleeve		M83796/1 or M83796/2 (Note 1)	-3 to -32	MS87018 or M83798/1	MS87020 or M83798/3
Style G - 45 Degrees to 45 Degrees  004t04e Style H - same as Style G but with fire sleeve		M83796/1 or M83796/2 (Note 1)	-3 to -32	MS87019 or M83798/2	MS87019 or M83798/2

Table 5. Synthetic Rubber Medium-Pressure Hose Assembly Per MIL-DTL-83796 (Cont)

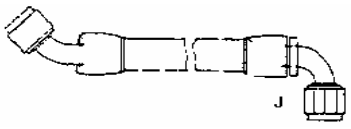
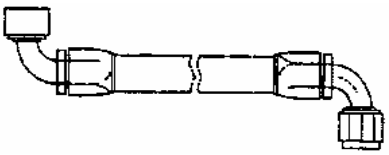
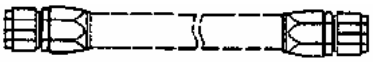
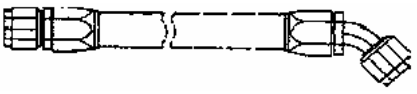
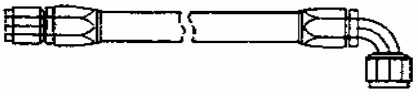
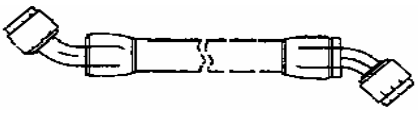
Flared to Flared (Cont)		Hose Assembly Part No. (Note 2)	Dash Size (Note 3)	Fittings	
A	B			A	B
Style J - 45 Degrees to 90 Degrees  004t04f Style K - same as Style J but with fire sleeve		M83796/1 or M83796/2 (Note 1)	-3 to -32	MS87019 or M83798/2	MS87020 or M83798/3
Style L - 90 Degrees to 90 Degrees  004t04g Style M - same as Style L but with fire sleeve		M83796/1 or M83796/2 (Note 1)	-3 to -32	MS87020 or M83798/3	MS87020 or M83798/3
Flareless to Flareless		**Hose Assembly Part No. (Note 2)**	**Dash Size (Note 3)**	**Fittings**	
A	**B**			**A**	**B**
Style A - Straight to Straight  004t04h Style B - same as Style A but with fire sleeve		M83796/3 or M83796/4 (Note 1)	-3 to -32	MS87021 or M83798/4	MS87021 or M83798/4
Style C - Straight to 45 Degrees  004t04i Style D - same as Style C but with fire sleeve		M83796/3 or M83796/4 (Note 4)	-3 to -32	MS87021 or M83798/4	MS87022 or M83798/5
Style E - Straight to 90 Degrees  004t04j Style F - same as Style E but with fire sleeve		M83796/3 or M83796/4 (Note 4)	-3 to -32	MS87021 or M83798/4	MS87023 or M83798/6
Style G - 45 Degrees to 45 Degrees  004t04k Style H - same as Style G but with fire sleeve		M83796/3 or M83796/4 (Note 4)	-3 to -32	MS87022 or M83798/5	MS87022 or M83798/5

Table 5. Synthetic Rubber Medium-Pressure Hose Assembly Per MIL-DTL-83796 (Cont)

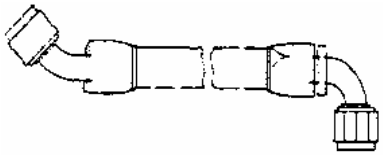
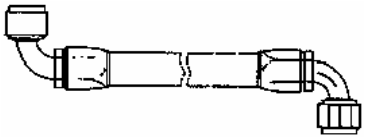
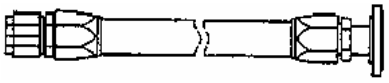
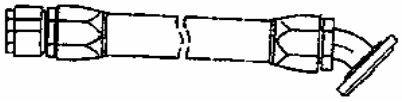
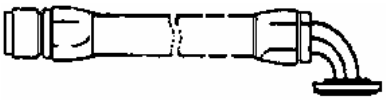
Flareless to Flareless (Cont)		Hose Assembly Part No. (Note 2)	Dash Size (Note 3)	Fittings	
A	B			A	B
Style J - 45 Degrees to 90 Degrees  004t04l Style K - same as Style J but with fire sleeve		M83796/3 or M83796/4 (Note 4)	-3 to -32	MS87022 or M83798/5	MS87023 or M83798/6
Style L - 90 Degrees to 90 Degrees  004t04m Style M - same as Style L but with fire sleeve		M83796/3 or M83796/4 (Note 4)	-3 to -32	MS87023 or M83798/6	MS87023 or M83798/6
Flared to Flanged		**Hose Assembly Part No. (Note 2)**	**Dash Size (Note 3)**	**Fittings**	
A	**B**			**A**	**B**
Style A - Straight to Straight  004t04n Style B - same as Style A but with fire sleeve		M83796/5 or M83796/6 (Note 5)	-8 to -32	MS87018 or M83798/1	MS87024 or M83798/7
Style C - Straight to 45 Degrees  004t04o Style D - same as Style C but with fire sleeve		M83796/5 or M83796/6 (Note 5)	-8 to -32	MS87018 or M83798/1	MS87025 or M83798/8
Style E - Straight to 90 Degrees  004t04p Style F - same as Style E but with fire sleeve		M83796/5 or M83796/6 (Note 5)	-8 to -32	MS87018 or M83798/1	MS87026 or M83798/9

Table 5. Synthetic Rubber Medium-Pressure Hose Assembly Per MIL-DTL-83796 (Cont)

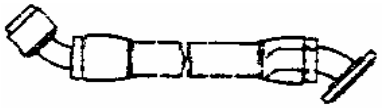
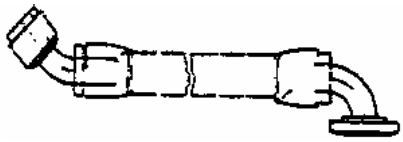
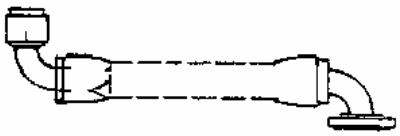
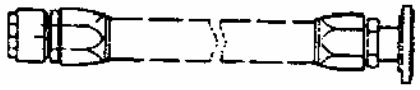
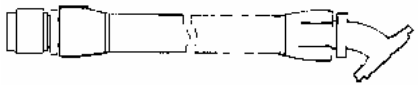
Flared to Flanged (Cont)		Hose Assembly Part No. (Note 2)	Dash Size (Note 3)	Fittings	
A	B			A	B
Style G - 45 Degrees to 45 Degrees  004t04q Style H - same as Style G but with fire sleeve		M83796/5 or M83796/6 (Note 5)	-8 to -32	MS87019 or M83798/2	MS87025 or M83798/8
Style J - 45 Degrees to 90 Degrees  004t04r Style K - same as Style J but with fire sleeve		M83796/5 or M83796/6 (Note 5)	-8 to -32	MS87019 or M83798/2	MS87026 or M83798/9
Style L - 90 Degrees to 90 Degrees  00404ts Style M - same as Style L but with fire sleeve		M83796/5 or M83796/6 (Note 5)	-8 to -32	MS87020 or M83798/6	MS87026 or M83798/9
Flareless to Flanged		**Hose Assembly Part No. (Note 2)**	**Dash Size (Note 3)**	**Fittings**	
A	**B**			**A**	**B**
Style A - Straight to Straight  004t04t Style B - same as Style A but with fire sleeve		M83796/7 or M83796/8 (Note 6)	-3 to -24	MS87021 or M83798/4	MS87024 or M83798/7
Style C - Straight to 45 Degrees  004004tu Style D - same as Style C but with fire sleeve		M83796/7 or M83796/8 (Note 6)	-3 to -24	MS87021 or M83798/4	MS87025 or M83798/8

Table 5. Synthetic Rubber Medium-Pressure Hose Assembly Per MIL-DTL-83796 (Cont)

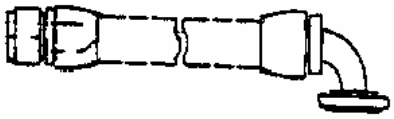
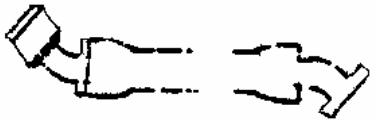
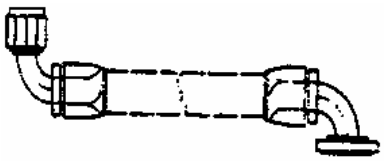
Flareless to Flanged (Cont)		Hose Assembly Part No. (Note 2)	Dash Size (Note 3)	Fittings	
A	B			A	B
Style E - Straight to 90 Degrees  004t04v Style F - same as Style E but with fire sleeve		M83796/7 or M83796/8 (Note 6)	-3 to -24	MS87021 or M83798/4	MS87026 or M83798/9
Style G - 45 Degrees to 45 Degrees  004t04w Style H - same as Style G but with fire sleeve		M83796/7 or M83796/8 (Note 6)	-3 to -24	MS87022 or M83798/5	MS87025 or M83798/8
Style J - 45 Degrees to 90 Degrees  004t04x Style K - same as Style J but with fire sleeve		M83796/7 or M83796/8 (Note 6)	-3 to -24	MS87022 or M83798/5	MS87026 or M83798/9
Style L - 90 Degrees to 90 Degrees  004t04y Style M - same as Style L but with fire sleeve		M83796/7 or M83796/8 (Note 6)	-3 to -24	MS87023 or M83798/6	MS87026 or M83798/9

Table 5. Synthetic Rubber Medium-Pressure Hose Assembly Per MIL-DTL-83796 (Cont)

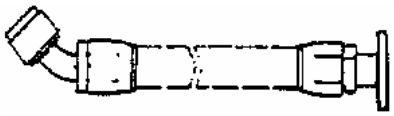
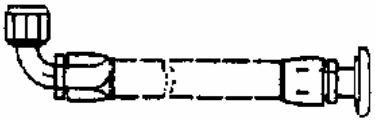
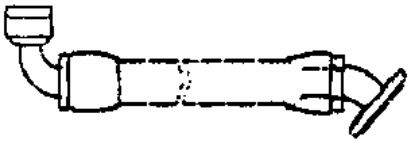
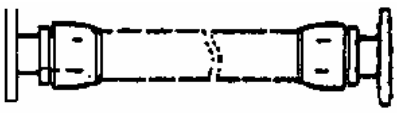
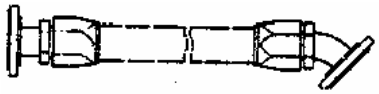
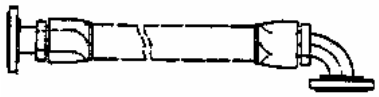
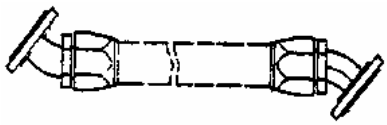
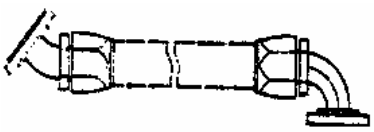
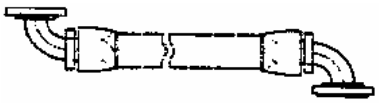
Flareless to Flanged (Cont)		Hose Assembly Part No. (Note 2)	Dash Size (Note 3)	Fittings	
A	B			A	B
Style N - 45 Degrees to Straight  004t04z Style P - same as Style N but with fire sleeve		M83796/7 or M83796/8 (Note 6)	-3 to -24	MS84022 or M83798/5	MS87024 or M83798/7
Style R - 90 Degrees to Straight  004t04aa Style S - same as Style R but with fire sleeve		M83796/7 or M83796/8 (Note 6)	-3 to -24	MS84023 or M83798/6	MS87026 or M83798/7
Style T - 90 Degrees to 45 Degrees  004t04ab Style U - same as Style T but with fire sleeve		M83796/7 or M83796/8 (Note 6)	-3 to -24	MS87023 or M83798/6	MS87025 or M83798/8
Flanged to Flanged		**Hose Assembly Part No. (Note 2)**	**Dash Size (Note 3)**	**Fittings**	
A	**B**			**A**	**B**
Style A - Straight to Straight  004t04ac Style B - same as Style A but with fire sleeve		M83796/9	-8 to -32	MS87024 or M83796/7	MS87024 or M83796/7

Table 5. Synthetic Rubber Medium-Pressure Hose Assembly Per MIL-DTL-83796 (Cont)

Flanged to Flanged (Cont)		Hose Assembly Part No. (Note 2)	Dash Size (Note 3)	Fittings	
A	B			A	B
Style C - Straight to 45 Degrees  004t04ad Style D - same as Style C but with fire sleeve		M83796/9	-8 to -32	MS87024 or M83798/7	MS87025 or M83798/8
Style E - Straight to 90 Degrees  004t04ae Style F - same as Style E but with fire sleeve		M83796/9	-8 to -32	MS87024 or M83798/7	MS87026 or M83798/9
Style G - 45 Degrees to 45 Degrees  004t04af Style H - same as Style G but with fire sleeve		M83796/9	-8 to -32	MS87025 or M83798/8	MS87025 or M83798/8
Style J - 45 Degrees to 90 Degrees  004t04ag Style K - same as Style J but with fire sleeve		M83796/9	-8 to -32	MS87025 or M83798/8	MS87026 or M83798/9
Style L - 90 Degrees to 90 Degrees  004t04ah Style M - same as Style L but with fire sleeve		M83796/9	-8 to -32	MS87026 or M83798/9	MS87026 or M83798/9

Notes:
1. Same as M83796/1, but with lockwire hole.
2. The part no. shall be made to reflect the hose assembly tube OD, length, style and angle between elbows (as applicable).
3. Flanged fittings are not available in sizes -3, -4, and -6.
4. Same as M83796/3, but with lockwire hole.
5. Same as M83796/5, but with lockwire hole.
6. Same as M83796/7, but with lockwire hole.

Table 6: Performance Characteristics of MIL-DTL-83796 Light Weight, Medium Pressure Rubber Hose

Test Condition (Note 1)	-3	-4	-5	-6	-8	-10	-12	-16	-20	-24	-32
Operating Pressure (Note 2)	1000	1000	1000	1000	1000	1000	1000	750	500	250	200
Proof Pressure (Note 3)	3000	3000	3000	3000	2500	2500	2000	1500	1300	800	600
Burst Pressure (Note 3)	6000	6000	6000	6000	5000	5000	3750	2500	2000	1750	1200
Minimum Bend Radius (in.)	1.75	2.00	2.25	2.50	3.50	4.00	4.50	5.50	8.00	9.00	12.5

Note 1: Typical operating pressures and burst pressures are included for information purposes only.
Note 2: Pressures are maximum (psi max)
Note 3: Pressures are minimum (psi min)

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

FABRICATION

PTFE MEDIUM AND PTFE HIGH PRESSURE HOSE ASSEMBLIES

Reference Material

Hoses, Hose Assemblies, and Fittings, Description WP003 00
Hose and Hose Assembly, Maintenance WP005 00
Hose and Hose Assembly, Quality Assurance WP006 00
Fuel and Hydraulic System Protective Closures, Description WP007 00
Hose Assembly, Rubber, Lightweight, Medium-Pressure, General Specification for MIL-DTL-83796
Hose Assembly, Tetrafluoroethylene, High Temperature, Medium-Pressure MIL-DTL-25579

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Record of Applicable Technical Directives

None

1. GENERAL.

2. This Work Package describes the process for constructing PTFE medium and PTFE high pressure hose assemblies per the following specifications:

PTFE Medium Pressure Hose Assemblies:

- MIL-DTL-27267

PTFE High Pressure Hose Assemblies:

- MIL-DTL-83298

NOTE

Many 'MS' part numbers have been changed to 'AS' part numbers. Cross referencing 'AS' part numbers to 'MS' part numbers may be necessary in some cases.

3. Fabricating hose assemblies from bulk hose and end fittings requires some basic skills and a few hand tools. The skills required are the ability to follow step-by-step instructions and the ability to manipulate the hand tools required.

WARNING

When cutting or stripping nylon core and synthetic rubber with a high speed cutting machine, ensure proper ventilation is available and approved by local Occupational Safety and Health.

Use of compressed air can create an environment of propelled particles. Do not direct air streams towards self or other personnel. Air pressure shall be reduced to less than 30 PSIG and used with effective chip guarding and personal protective equipment.

SEE IRAC #6

4. MEDIUM-PRESSURE PTFE HOSE ASSEMBLIES MIL-DTL-25579 AND HIGH-PRESSURE PTFE HOSE ASSEMBLIES AS604/AS1339 (FORMERLY MIL-H-38360). Use bulk hose MIL-DTL-27267 with fittings MIL-F-27272 for medium pressure (Table 1) and bulk hose MIL-DTL-83298 with fittings MIL-F-83296 for high pressure (Table 2). Fabrication instructions for both types of hose assemblies are the same. See Tables 3 and 4 for Performance Characteristics including proof pressure and bend radius data.

CAUTION

Non-QPL hose and fittings such as AE246 may not be interchanged with qualified MIL-DTL-83298 hose and MIL-F-83296 fittings. QPL hoses accommodate -4 thru -10 sizes only. Do not fabricate hose assemblies larger than -12.

SEE IRAC #6

SEE IRAC #6

5. Medium- and High-Pressure PTFE Hose Assemblies With Single or Double Straight Fittings. To fabricate medium- and high-pressure PTFE hose assemblies with single or double straight fittings, proceed as follows:

a. Determine hose length from WP 004 00: Figure 7 and Table 6.

b. Wrap circumference of hose with masking or plastic electrical tape at cutoff to prevent flareout of braid.

c. Measure hose to required length and cut off square, using cutoff machine.

d. Blow hose clean with filtered shop air after cutting.

e. Remove tape after cutting hose.

CAUTION

Do not overtighten vise on thin-walled lightweight fittings.

f. Clamp two sockets skirt-to-skirt in vise.

g. Insert neck-down end of hose into socket, using a twisting, pushing motion until hose is through the sockets (Figure 1). Remove assembly from vise.

h. Clamp nipple in vise.

NOTE

Do not lubricate hose or nipple before insertion. Fitting components are dryfilm lubricated at time of manufacture.

i. Push one end of hose into nipple to size inner tube and to aid in separating wire braid from tube (Figure 2).

j. Remove hose from nipple. Do not remove nipple from vise.

CAUTION

Do not allow any wire braid to become trapped between sleeve and tube or bent under remaining braid.

k. Insert sleeve between braid and outer diameter of the inner tube.

l. Complete positioning of sleeve by pushing sleeve against a flat surface until tube bottoms against shoulder of inside sleeve diameter (Figure 3).

m. Check tube end to make sure it is bottomed against sleeve shoulder and wires are not trapped under sleeve.

n. Size tube to sleeve by pushing hose over nipple until sleeve bottoms against nipple chamfer.

o. Remove hose and sleeve from nipple.

p. Check end to make sure sleeve is positioned properly.

q. Reinstall hose onto nipple.

r. Slide socket forward and thread onto nipple by hand (Figure 4).

s. Reposition assembly by placing socket flats in vise (Figure 5).

CAUTION

For AE fittings (size -12 only), socket must be preseated prior to thread engagement. With the socket held firmly in a vise, insert socket preseat hand tool, Part No. S1272-8-1 (00624) into the hose. Using a nonferrous hammer, tap the preseating tool forcing the sleeve into the socket until the threaded end of the socket bottoms against the shoulder on the preseating tool (Figure 6).

t. Tighten assembly by using a wrench on the nipple hex until gap between socket hex and nipple hex is 1/32 inch. Gap may vary from .023 to .046 inch.

NOTE

Repeat steps e through t for hose assembly with straight fittings on both ends.

u. Clean, inspect, test, identify and prepare hose assembly for installation or storage in accordance with WP003 00 thru WP006 00.

6. Medium- and High-Pressure PTFE Hose Assemblies With a Single Elbow Fitting. To fabricate medium- and high-pressure PTFE hose assemblies with a single elbow fitting, proceed as described in Paragraph 5.

7. Medium- and High-Pressure PTFE Hose Assemblies With Double-Ended Elbow Fittings. To fabricate medium- and high-pressure PTFE hose assemblies with double-ended elbow fittings, proceed as follows:

a. Determine hose length from WP 004 00: Figure 7 and Table 6.

b. Wrap circumference of hose with masking or plastic electrical tape at cutoff to prevent flareout of braid.

c. Measure hose to required length and cut off square, using cutoff machine.

d. Blow hose clean with filtered shop air after cutting.

e. Remove tape after cutting hose.

CAUTION

Do not overtighten vise on thin-walled lightweight fittings.

f. Clamp two sockets skirt-to-skirt in vise.

g. Insert neck-down end of hose into socket, using a twisting, pushing motion until hose is through the sockets (Figure 1). Remove assembly from vise.

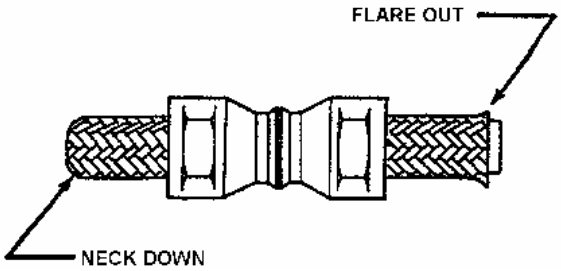
h. Clamp nipple in vise.

NOTE

Do not lubricate hose or nipple before insertion. Fitting components are dryfilm lubricated at time of manufacture.

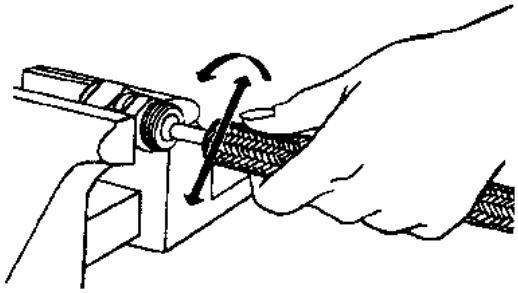
i. Push one end of hose into nipple to size inner tube and to aid in separating wire braid from tube (Figure 2).

j. Remove hose from nipple. Do not remove nipple from vise.



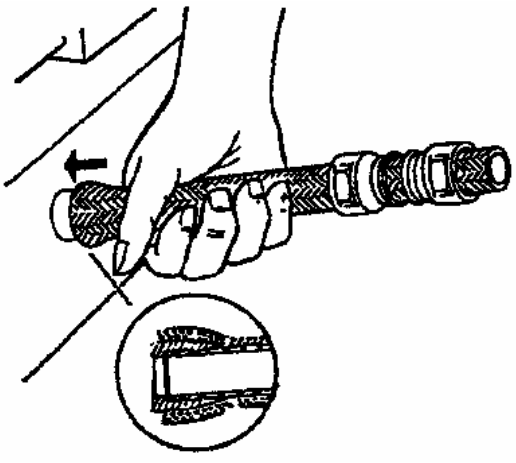
004024

Figure 1. Socket Assembly



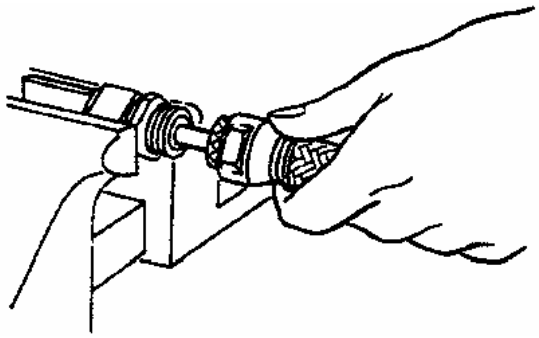
004025

Figure 2. Sizing Hose



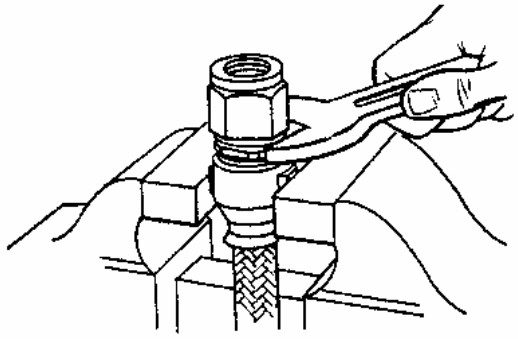
004026

Figure 3. Positioning Sleeve



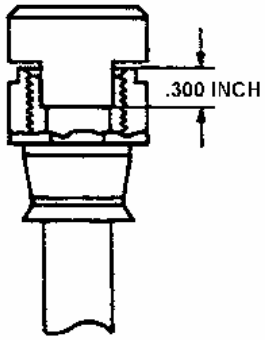
004027

Figure 4. Positioning Socket and Nipple



004028

Figure 5. High-Pressure Hose Tightening Assembly



004029

Figure 6. Preseating Socket on AE Fitting (Size 12)

CAUTION

Do not allow any wire braid to become trapped between sleeve and tube or bent under remaining braid.

k. Insert sleeve between braid and outer diameter of the inner tube.

l. Complete positioning of sleeve by pushing sleeve against a flat surface until tube bottoms against shoulder of inside sleeve diameter (Figure 3).

m. Check tube end to make sure it is bottomed against sleeve shoulder and wires are not trapped under sleeve.

n. Size tube to sleeve by pushing hose over nipple until sleeve bottoms against nipple chamfer.

o. Remove hose and sleeve from nipple.

p. Check end to make sure sleeve is positioned properly.

q. Reinstall hose onto nipple.

r. Slide socket forward and thread onto nipple by hand (Figure 4).

s. Clamp socket in vise so the opposite end fitting points downward. Make sure hose does not have an axial twist.

t. While opposite fitting is still loose enough to swivel by hand, turn to required angle and measure, using an adjustable protractor.

CAUTION

For AE fittings (size -12 only), socket must be presented prior to thread engagement. With the socket held firmly in a vise, insert socket preseat hand tool, Part No. S1272-8-1 (00624) into the hose. Using a non-ferrous hammer, tap the preseating tool forcing the sleeve into the socket until the threaded end of the socket bottoms against the shoulder on the preseating tool (Figure 6).

u. Use a wrench on elbow hex to turn nipple assembly clockwise until elbow hex is within 1/32 inch of the socket. Gap may vary from .023 to .046.

v. Clean, inspect, test, identify and prepare hose assembly for installation or storage per WP003 00 thru WP006 00.

8. PREFORMED HOSE ASSEMBLIES.

9. Medium-pressure PTFE hose assemblies are sometimes performed to clear obstructions and to make connections using the shortest possible hose length. Since preforming permits tighter bends, eliminating need for special elbows, preformed hose assemblies save space and weight. Preformed hose assemblies shall be procured from a qualified commercial source (source code P series). When preformed hose assemblies are unavailable and could cause a work stoppage, fabrication by Depot and Intermediate Maintenance is authorized. The requirements of this manual apply to preformed hose fabrication, handling, storage, and installation.

10. Preformed Medium-Pressure PTFE Hose. The following steps shall be taken to fabricate preformed medium-pressure PTFE hose:

a. Preheat oven to 400°F to 410°F.

Aircraft Exterior Cleaning Compound, MIL-PRF-85570, Type II **4**

b. Clean hose surfaces with mixture of one part detergent MIL-PRF-85570, Type II, and nine parts of tap water. Use a nylon or similar bristle brush with a corrosion-resistant core.

c. Rinse hose thoroughly with tap water and air dry.

WARNING

Use heat-resistant protective gloves when handling heated hoses.

d. Position hose into oven where hose can be heated uniformly at 400°F to 410°F for 5 to 10 minutes.

CAUTION

Speed is essential in preforming hoses. If a hose is difficult to position in fixture and step (e) takes more than 10 seconds to complete, return hose with fixture to oven for an additional 4 to 5 minutes. Total time for steps (e) and (f) shall not exceed 15 seconds.

e. Remove hose from oven, insert internal support if required, and place hose in forming fixture quickly.

f. Quickly place fixture with hose into quenching tank. Completely submerge fixture and hose in water that is maintained at a temperature range of 35°F to 85°F.

g. Remove fixture with hose from quenching tank after hose has quenched to water temperature. Remove hose from fixture and support from hose.

h. Air dry hose.

i. Trim hose ends and assembly end fittings.

j. Position completed assembly in fixture and proof pressure test per WP 004 00.

k. Remove hose assembly from fixture and restrain the preformed portion of the hose with wire, metal, or plastic forms until assembly is ready for installation.

l. Clean, inspect, identify and prepare for installation or storage per WP003 00 thru WP006 00.

11. (AIR FORCE ONLY) MACHINE ASSEMBLY PROCEDURE.

12. (AF) Tools and Equipment Required.

a. **(AF)** Hose Cut-Off Machine, FSN 4940-348-4798.

b. **(AF)** Hose Assembly Machine, FSN 4940-601-6985.

WARNING **(AF)**

Use of compressed air can create an environment of propelled particles. Do not direct air streams towards self or other personnel. Air pressure shall be reduced to less than 30 PSIG and used with effective chip guarding and personal protective equipment.

13. (AF) Machine Assembly Procedure.

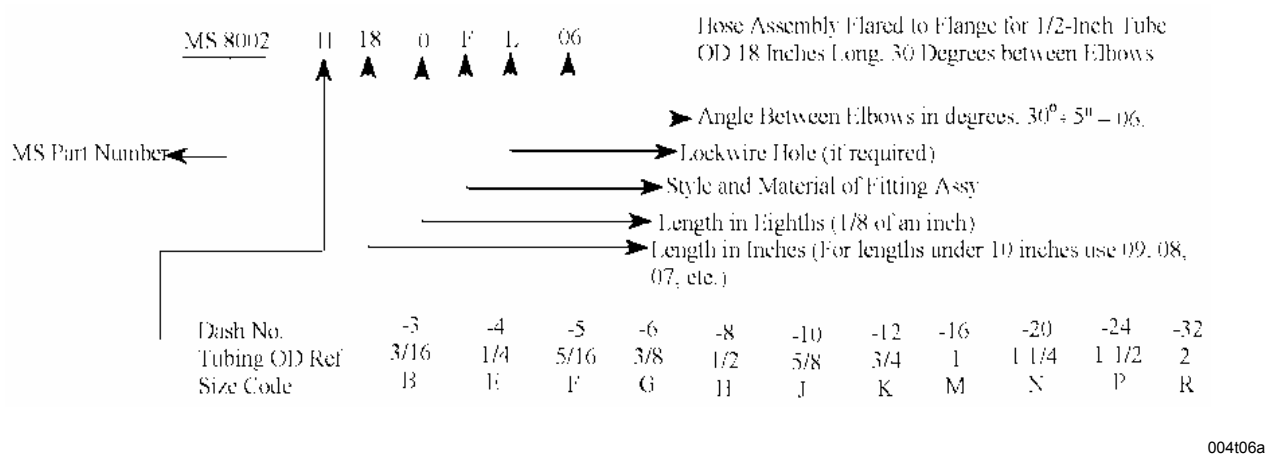
a. **(AF)** Clean hose assembly with compressed air.

b. **(AF)** Inspect and proof test. See WP 005 and 006.

c. **(AF)** After proof-test, the hose assembly shall be identified in accordance to instructions in WP 004 00.

d. **(AF)** Install fire sleeve as necessary per instruction in WP 004 00.

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579



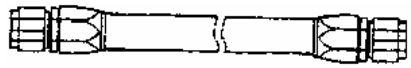
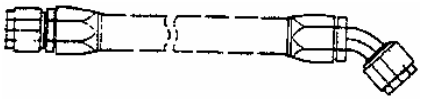
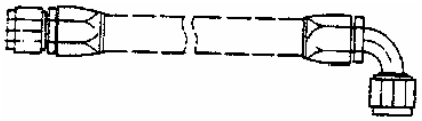
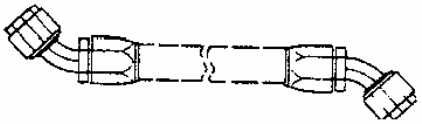
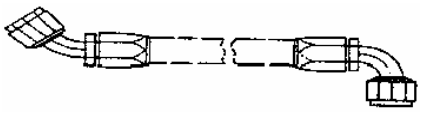
Flared to Flared		Hose Assembly Part No. MS8000 (Note 2)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06b		Style A	-3/-4 thru -24	MS27053	MS27053
 004t06c		Style B	-3/-4 thru -8 -10 thru -24	MS27053 MS27053	MS27059 MS27055
 004t06d		Style C	-3/-4 thru -8 -10 thru -24	MS27053 MS27053	MS27060 MS27060
 004t06e		Style D	-3/-4 thru -8 -10 thru -24	MS27059 MS27055	MS27059 MS27055
 004t06f		Style E	-3/-4 thru -8 -10 thru -24	MS27059 MS27055	MS27059 MS27055

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579 (Cont)

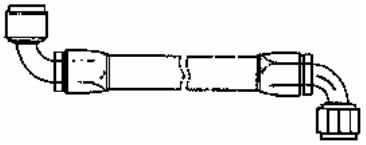
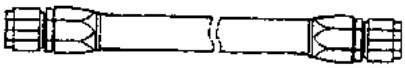
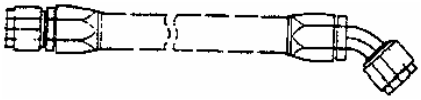
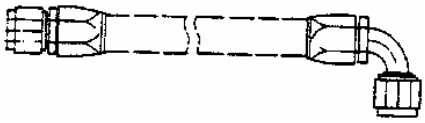
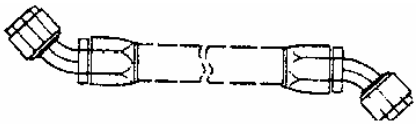
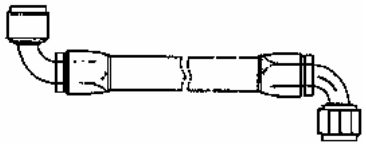
Flared to Flared (Cont)		Hose Assembly Part No. MS8000 (Note 2)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06g		Style F	-3/-4 thru -8 -10 thru -24	MS27060 MS27057	MS27060 MS27057
 004t06h		Style G	-8 thru -24	MS27053	MS27053
 004t06i		Style H	-8 -10 thru -24	MS27053 MS27053	MS27059 MS27055
 004t06j		Style J	-8 -10 thru -24	MS27053 MS27053	MS27060 MS27057
 004t06k		Style K	-8 -10 thru -24	MS27059 MS27055	MS27059 MS27055
 004t06l		Style M	-8 -10 thru -24	MS27059 MS27055	MS27060 MS27057
 004t06m		Style N	-8 -10 thru -24	MS27060 MS27057	MS27060 MS27057

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579 (Cont)

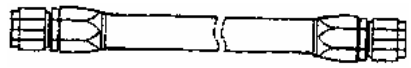
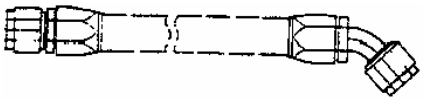
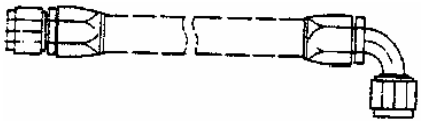
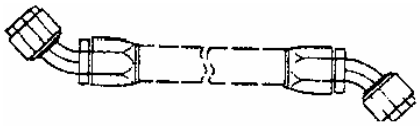
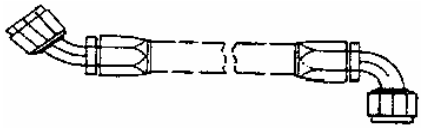
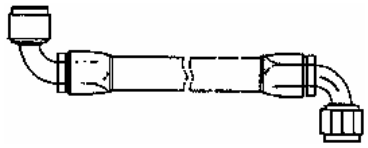
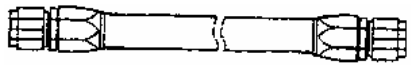
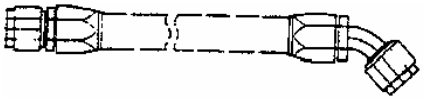
Flareless to Flareless		Hose Assembly Part No. MS8001 (Note 2)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06n		Style A	-3/-4 thru -24	MS27381	MS27381
 004t06o		Style B	-3/-4 thru -8 -10 thru -24	MS27381 MS27381	MS27384 MS27382
 004t06p		Style C	-3/-4 thru -8 -10 thru -24	MS27381 MS27381	MS27385 MS27383
 004t06q		Style D	-3/-4 thru -8 -10 thru -24	MS27384 MS27382	MS27384 MS27382
 004t06r		Style E	-3/-4 thru -8 -10 thru -24	MS27384 MS27382	MS275385 MS275383
 004t06s		Style F	-3/-4 thru -8 -10 thru -24	MS27385 MS27383	MS27385 MS27383
 004t06t		Style G	-8 thru -24	MS27381	MS27381
 004t06u		Style H	-8 -10 thru -24	MS27381 MS27381	MS27384 MS27382

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579 (Cont)

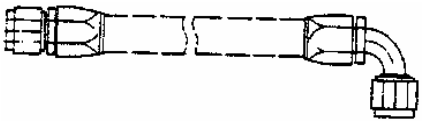
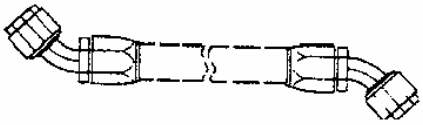
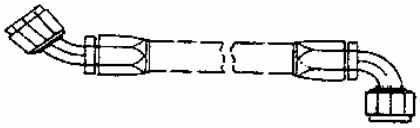
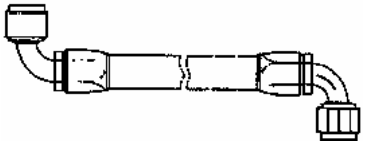
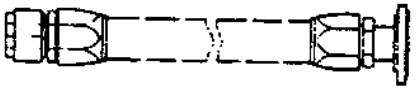
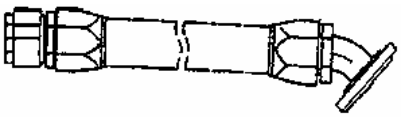
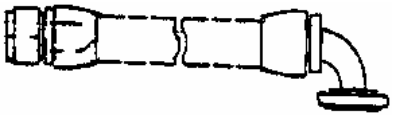
Flareless to Flareless (Cont)		Hose Assembly Part No. MS8001 (Note 2)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06v		Style J	-8 -10 thru -24	MS27381 MS27381	MS27385 MS27383
 004t06w		Style K	-8 -10 thru -24	MS27384 MS27382	MS27384 MS27382
 004t06x		Style M	-8 -10 thru -24	MS27384 MS27382	MS27385 MS27383
 004t06y		Style N	-8 -10 thru -24	MS27385 MS27383	MS27385 MS27383
Flared to Flanged		**Hose Assembly Part No. MS8002 (Note 3)**	**Dash Size**	**Fittings (Notes 5 and 6)**	
A	**B**			**A**	**B**
 004t06z		Style A	-8 thru -24	MS27053	MS27054
 004t06aa		Style B	-8 thru -24	MS27053	MS27056
 004t06ab		Style C	-8 thru -24	MS27053	MS27058

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579 (Cont)

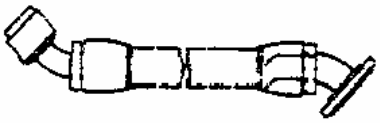
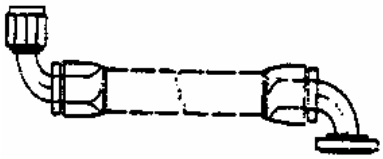
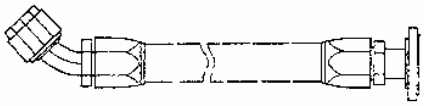
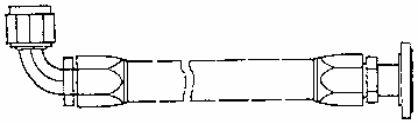
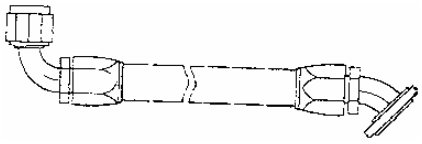
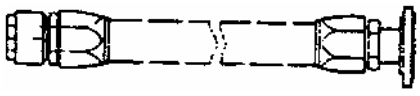
Flared to Flanged (Cont)		Hose Assembly Part No. MS8002 (Note 3)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06ac		Style D	-8 -10 thru -24	MS27059 MS27055	MS27056 MS27056
 004t06ae		Style E	-8 -10 thru -24	MS27059 MS27055	MS27058 MS27058
 004t06ae		Style F	-8 -10 thru -24	MS27060 MS27057	MS27058 MS27058
 004t06af		Style G	-8 -10 thru -24	MS27059 MS27055	MS27054 MS27054
 004t06ag		Style H	-8 -10 thru -24	MS27060 MS27057	MS27054 MS27054
 004t06ah		Style J	-8 -10 thru -24	MS27060 MS27057	MS27056 MS27056
 004t06ai		Style K	-8 thru -24	MS27053	MS27054

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579 (Cont)

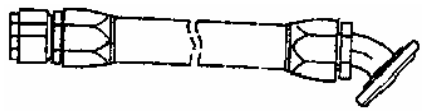
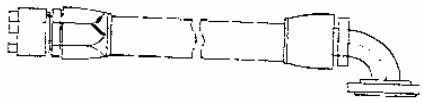
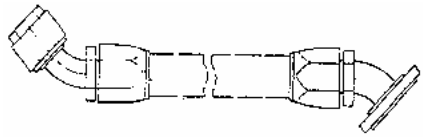
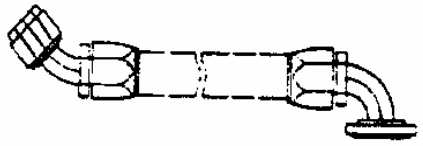
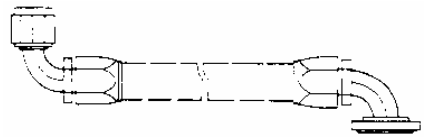
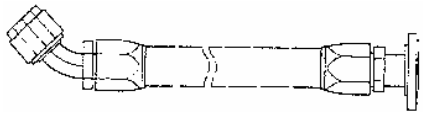
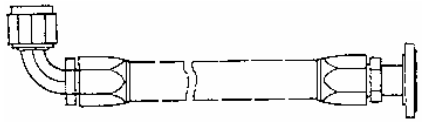
Flared to Flanged (Cont)		Hose Assembly Part No. MS8002 (Note 3)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06aj		Style M	-8 thru -24	MS27053	MS27056
 004t06ak		Style N	-8 thru -24	MS27053	MS27058
 004t06al		Style P	-8 -10 thru -24	MS27059 MS27055	MS27056 MS27056
 004t06am		Style R	-8 -10 thru -24	MS27059 MS27055	MS27058 MS27058
 004t06an		Style S	-8 -10 thru -24	MS27060 MS27057	MS27058 MS27058
 004t06ao		Style T	-8 -10 thru -24	MS27059 MS27055	MS27054 MS27054
 004t06ap		Style U	-8 -10 thru -24	MS27060 MS27057	MS27054 MS27054

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579 (Cont)

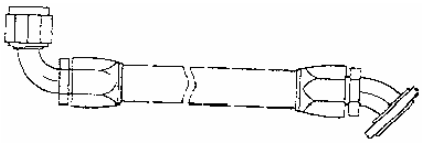
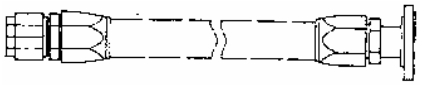
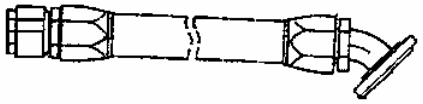
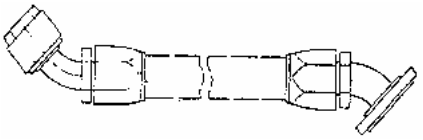
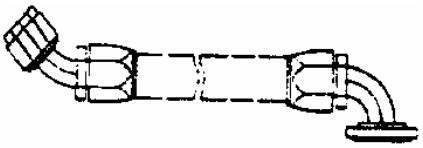
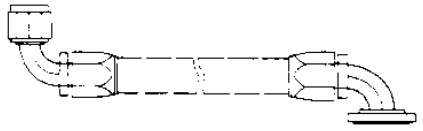
Flared to Flanged (Cont)		Hose Assembly Part No. MS8002 (Note 3)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06aq		Style V	-8 -10 thru -24	MS27060 MS27057	MS27056 MS27056
Flareless to Flange		**Hose Assembly Part No. MS8003 (Note 3)**	**Dash Size**	**Fittings (Notes 5 and 6)**	
A	**B**			**A**	**B**
 004t06ar		Style A	-8 thru -24	MS27381	MS27054
 004t06as		Style B	-8 thru -24	MS27381	MS27056
 004t06at		Style C	-8 thru -24	MS27381	MS27058
 004t06au		Style D	-8 -10 thru -24	MS27384 MS27382	MS27056 MS27056
 004t06av		Style E	-8 -10 thru -24	MS27384 MS27382	MS27058 MS27058
 004t06aw		Style F	-8 -10 thru -24	MS27385 MS27383	MS27058 MS27058

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579 (Cont)

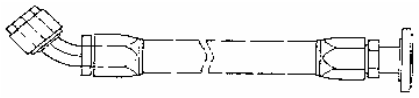
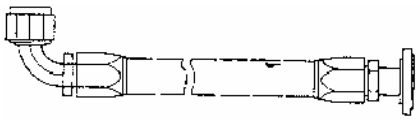
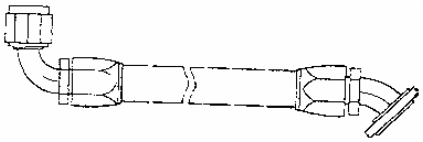
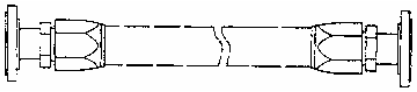
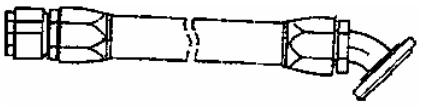
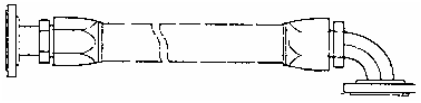
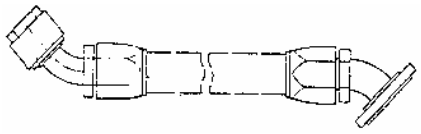
Flareless to Flange (Cont)		Hose Assembly Part No. MS8003 (Note 3)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06ax		Style G	-8 -10 thru -24	MS27384 MS27382	MS27054 MS27054
 004t06ay		Style H	-8 -10 thru -24	MS27385 MS27383	MS27054 MS27054
 004t06az		Style J	-8 -10 thru -24	MS27385 MS27383	MS27056
 004t06ba		Style K	-8 thru -24	MS27054	MS27054
 004t06bb		Style M	-8 thru -24	MS27381	MS27056
 004t06bc		Style N	-8 thru -24	MS27054	MS27058
 004t06bd		Style P	-8 -10 thru -24	MS27384 MS27382	MS27056

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579 (Cont)

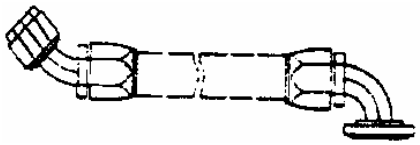
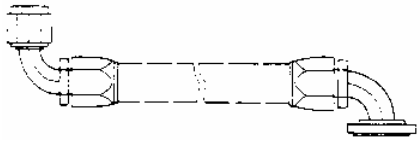
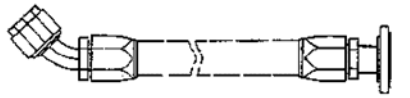
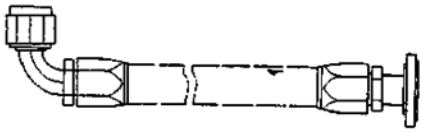
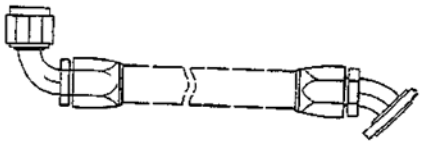
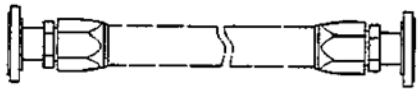
Flareless to Flange (Cont)		Hose Assembly Part No. MS8003 (Note 3)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06be		Style R	-8 -10 thru -24	MS27384 MS27382	MS27058 MS27058
 004t06bf		Style S	-8 -10 thru -24	MS27385 MS27383	MS27058
 004t06bg		Style T	-8 -10 thru -24	MS27384 MS27382	MS27054
 004t06bh		Style U	-8 -10 thru -24	MS27385 MS27383	MS27054
 004t06bi		Style Y	-8 -10 thru -24	MS27385 MS27383	MS27056
Flanged to Flanged		**Hose Assembly Part No. MS8004 (Note 2)**	**Dash Size**	**Fittings (Notes 5 and 6)**	
A	**B**			**A**	**B**
 004t06bj		Style A	-8 thru -24	MS27054	MS27054

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579 (Cont)

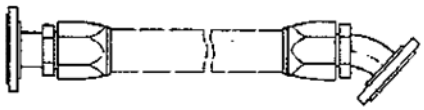
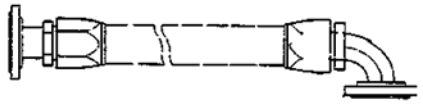
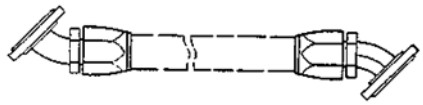
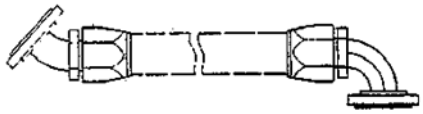
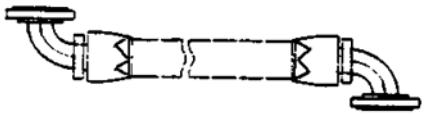
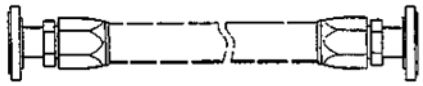
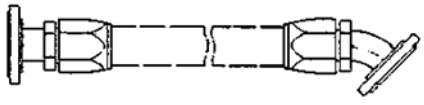
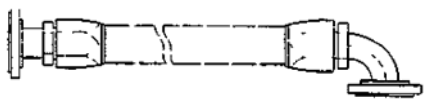
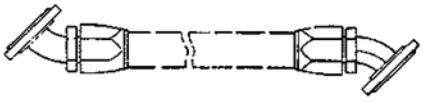
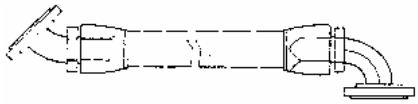
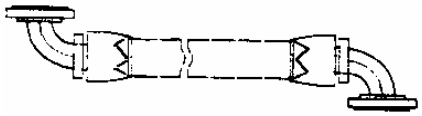
Flanged to Flanged (Cont)		Hose Assembly Part No. MS8004 (Note 2)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06bk		Style B	-8 thru -24	MS27054	MS27056
 004t06bl		Style C	-8 thru -24	MS27054	MS27058
 004t06bm		Style D	-8 thru -24	MS27056	MS27056
 004t06bn		Style E	-8 thru -24	MS27056	MS27058
 004t06bo		Style F	-8 thru -24	MS27058	MS27058
 004t06bp		Style G	-8 thru -24	MS27054	MS27054
 004t06bq		Style H	-8 thru -24	MS27054	MS27056
 004t06br		Style J	-8 thru -24	MS27054	MS27058

Table 1. Teflon Medium-Pressure Hose Assemblies Per MIL-DTL-25579 (Cont)

Flanged to Flanged (Cont)		Hose Assembly Part No. MS8004 (Note 2)	Dash Size	Fittings (Notes 5 and 6)	
A	B			A	B
 004t06bs		Style K	-8 thru -24	MS27056	MS27056
 004t06bt		Style M	-8 thru -24	MS27056	MS27058
 004t06bu		Style N	-8 thru -24	MS27058	MS27058

Notes:
1. The part no. shall be formulated to reflect the hose assembly tube OD, length, style and angle between elbows (As Applicable). Flanged fittings are not available in sizes -3, -4, -5, and -6.
2. For hose assemblies MS8000, MS8001, and MS8004, styles A through F are Corrosion-Resistant Steel (CRES), and G through N are aluminum and CRES.
3. For hose assemblies MS8002 and MS8003, styles A through J are CRES and K through V are aluminum and CRES.
4. MS part no. suffix code.
   No suffix = Aluminum with CRES sockets
   L suffix = Aluminum with CRES sockets and lockwire holes
   C suffix = All CRES
   CL suffix = All CRES with lockwire holes
5. Elbow fittings in sizes -3/-4 through -8 are forged construction.
6. Elbow fittings in sizes -10 and up are bent tube construction.

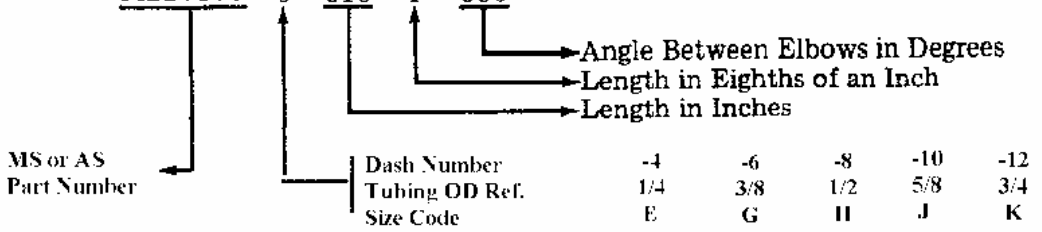
Table 2. PTFE High-Pressure (3000 psi) Hose Assemblies

The Part Number Shall Be Formulated to Reflect the Base Number, Size, Length and Angle.

Example of Part Number

MS27368 J 016 4 030

Hose Assembly Flared to Flared for 5/8-Inch Tube OD
16 1/2 Inches Long, 30 Degrees between Elbows



004t07a

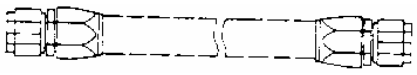
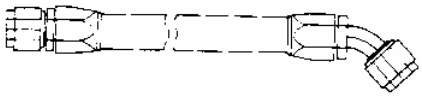
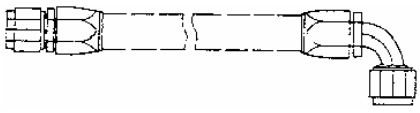
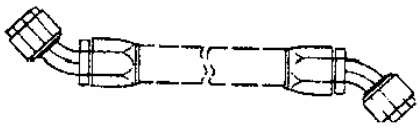
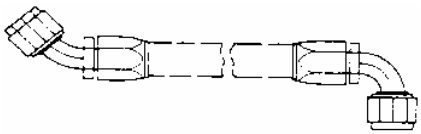
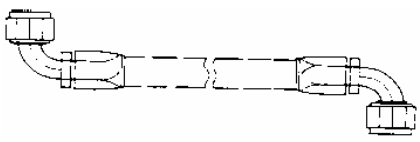
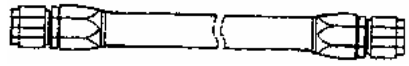
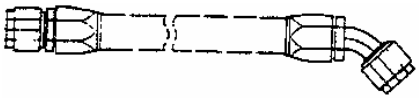
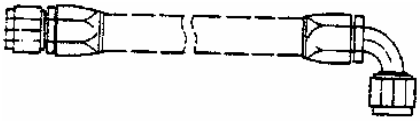
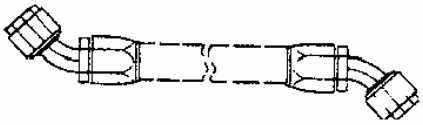
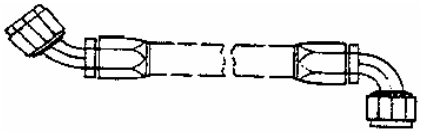
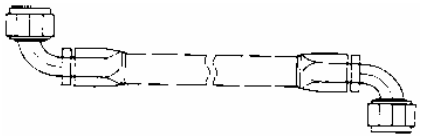
Flareless to Flareless		Hose Assembly Part No.	Dash Size (Notes 1 and 2)	Fittings	
A	B			A	B
 004t07b		AS115 or AS621	-4 thru -10/-12	MS27629	MS27629
 007t07c		AS116 or AS622	-4 thru -10/-12	MS27629	MS27630
 004t07d		AS117 or AS623	-4 thru -10/-12	MS27629	MS27631
 004t07e		AS118 or AS624	-4 thru -10/-12	MS27630	MS27630
 004t07f		AS119 or AS625	-4 thru -10/-12	MS27630	MS27631
 004t07g		AS120 or AS626	-4 thru -10/-12	MS27631	MS27631

Table 2. PTFE High-Pressure (3000 psi) Hose Assemblies (Cont)

Flared to Flared		Hose Assembly Part No.	Dash Size (Notes 1 and 2)	Fittings	
A	B			A	B
 004t07h		AS153 or AS627	-4 thru -10/-12	MS27616	MS27616
 004t07i		AS154 or AS628	-4 thru -10/-12	MS27616	MS27617
 004t07j		AS155 or AS629	-4 thru -10/-12	MS27616	MS27618
 004t07k		AS156 or AS630	-4 thru -10/-12	MS27617	MS27617
 004t07l		AS157 or AS631	-4 thru -10/-12	MS27617	MS27618
 004t07m		AS158 or AS632	-4 thru -10/-12	MS27618	MS27618

Notes: 1. MS elbow fittings in sizes -4 thru -8 are forged construction; size -10 is bent construction.
2. -12 size fittings are only available from Aeroquip Corporation and are designed for use with AE246 hose only.

SEE IRAC #6

SEE IRAC #6

Table 3: Performance Characteristics of MIL-DTL-27267 PTFE Medium Pressure Hose Assembly

Test Condition (Note 1)	-4	-5	-6	-8	-10	-12	-16 (Note 4)	-20 (Note 4)	-24 (Note 4)
Operating Pressure (Note 2)	1500	1500	1500	1500	1500	1000	1250	1000	1000
Proof Pressure (Note 3)	3000	3000	3000	3000	3000	2000	2500	2000	2000
Burst Pressure (Note 3)	12000	10000	9000	8000	7000	5000	5000	4000	4000
High Temperature Burst Pressures (Note 5)	7000	6500	6500	6000	5500	3500	3500	3000	3000
Minimum Bend Radius (in.)	2.00	2.00	4.00	4.62	5.50	6.50	7.38	11.00	14.00

Note 1: Typical operating pressures and burst pressures are included for information purposes only.
Note 2: Pressures are maximum (psi max)
Note 3: Pressures are minimum (psi min)
Note 4: Indicates two braided stainless steel reinforcement layers are mandatory
Note 5: Indicates high-temperature burst pressures

SEE IRAC #6

Table 4: Performance Characteristics of MIL-DTL-83298 PTFE High Pressure Hose Assembly

Test Condition (Note 1)	-4	-6	-8	-10
Operating Pressure (Note 2)	3000	3000	3000	3000
Proof Pressure (Note 3)	6000	6000	6000	6000
Burst Pressure (Note 3)	16000	14000	14000	12000
High Temperature Burst Pressures (Note 4)	12000	10500	10000	9000
Minimum Bend Radius (in.)	3.00	5.00	5.75	6.50

Note 1: Typical operating pressures and burst pressures are included for information purposes only.
Note 2: Pressures are maximum (psi max)
Note 3: Pressures are minimum (psi min)
Note 4: Indicates high-temperature burst pressures

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

FABRICATION

HIGH PRESSURE RUBBER HOSE ASSEMBLIES

Reference Material

Hoses, Hose Assemblies, and Fittings, Description WP003 00
Hose and Hose Assembly, Maintenance WP005 00
Hose and Hose Assembly, Quality Assurance WP006 00
Fuel and Hydraulic System Protective Closures, Description WP007 00
Hose Assemblies, Rubber Hydraulic, High-Pressure (3000 psi) MIL-DTL-8790

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Fabricating Hose Assemblies MIL-DTL-8790 with Straight Fitting on One End and Elbow Fitting on the Other End	5
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Record of Applicable Technical Directives

None

1. GENERAL.

2. This Work Package describes the process for constructing high pressure rubber hose assemblies per MIL-DTL-8790.

3. Fabricating hose assemblies from bulk hose and end fittings requires some basic skills and a few hand tools. The skills required are the ability to follow step-by-step instructions and the ability to manipulate the hand tools required.

WARNING

When cutting or stripping nylon core and synthetic rubber with a high speed cutting machine, ensure proper ventilation is available and approved by local Occupational Safety and Health.

Use of compressed air can create an environment of propelled particles. Do not direct air streams towards self or other personnel. Air pressure shall be reduced to less than 30 PSIG and used with effective chip guarding and personal protective equipment.

4. HIGH-PRESSURE SYNTHETIC RUBBER HOSE ASSEMBLIES MIL-DTL-8790. Use bulk hose MIL-DTL-8788 to fabricate high-pressure synthetic rubber hose assembly MIL-DTL-8790 (Table 1). See Table 2 for Performance Characteristics including proof pressure and bend radius data.

CAUTION

Do not reuse aluminum sockets when fabricating hose assemblies MIL-DTL-8790.

NOTE

Use Stratoflex hose, Part No. 112 or Aeroquip hose, Part No. AE639, for gaseous application.

5. HAND TOOL ASSEMBLY PROCEDURE

6. Fabricating Hose Assemblies MIL-DTL-8790 with Single or Double Straight Fittings. To fabricate high pressure synthetic rubber hose assemblies MIL-DTL-8790 with straight fittings, proceed as follows:

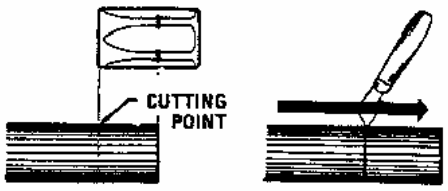
a. Determine hose length from WP 004 00: Figure 7 and Table 6.

b. Measure hose to required length and cut off square, using cutoff machine.

c. Blow hose clean with filtered shop air after cutting.

d. Using the notch on the socket to determine the amount of outer cover to strip, score the circumference of the hose down to the wire reinforcement (Figure 1).

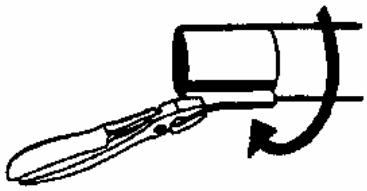
e. Make an axial (lengthwise) slit to the cutoff end (Figure 1).



004017

Figure 1. Marking Outer Cover

f. Pry up a corner of axial slit, using slipjoint pliers, and twist off outer cover down to wire braid (Figure 2).



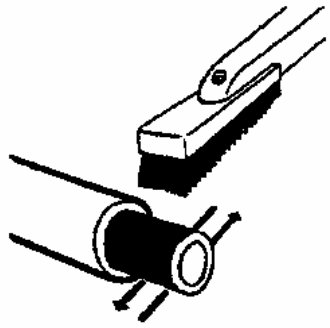
004018

Figure 2. Removing Cover

CAUTION

Do not loosen or break wires when cleaning hoses.

g. Wire brush to remove particles of rubber cover from exposed wire braid (Figure 3).

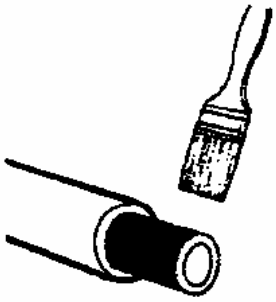


004019

Figure 3. Cleaning Wire Braid

Gasket Sealing Compound, MIL-S-45180, Type II **3**

h. Using a paint brush, apply a uniform coating of sealant MIL-S-45180, Type II to exposed wire braid (Figure 4).



004020

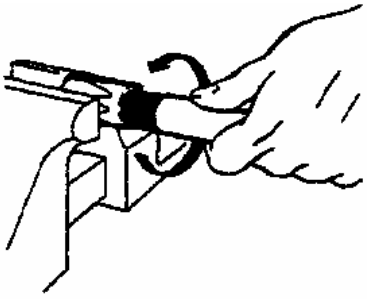
Figure 4. Applying Sealant

CAUTION

Do not overtighten vise on thin-walled lightweight fittings.

i. Clamp socket in vise.

j. Screw hose counterclockwise into socket (Figure 5) with a twisting, pushing motion until hose bottoms on socket shoulder.



004021

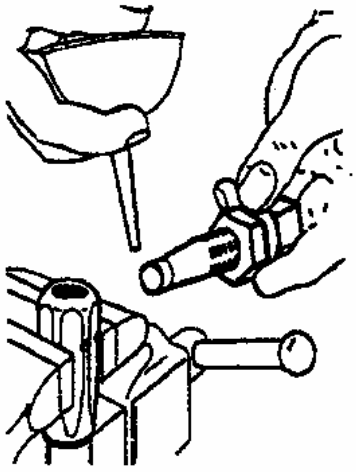
Figure 5. High-Pressure Hose Insertion

k. Back out hose 1 /4 turn.

Hydraulic Fluid, MIL-PRF-83282 **1**

Hydraulic Fluid, MIL-DTL-81019 **2**

l. Lubricate inside bore of hose and outer surface of nipple assembly with hydraulic fluid MIL-PRF-83282 (Figure 6).



004022

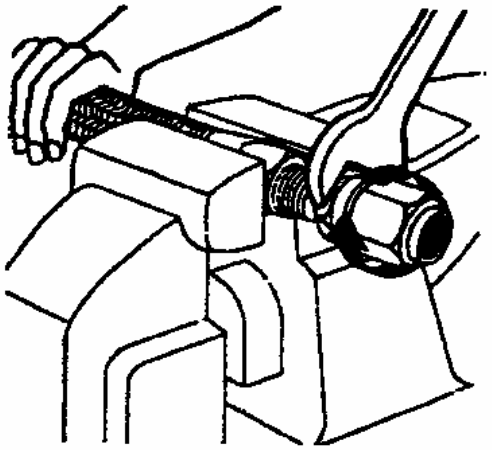
Figure 6. High-Pressure Hose Assembly Lubrication

CAUTION

Do not overtighten vise on thin-walled lightweight fittings.

m. Clamp socket with hose in vise.

n. Insert nipple assembly into hose and socket using a wrench on the nipple hex (Figure 7).



004023

Figure 7. Tightening Nipple

o. Turn assembly clockwise until hex to socket gap is no greater than 1/32 inch.

NOTE

Repeat steps d through o for hose assembly with straight fittings on both ends.

p. Clean, inspect, test, identify and prepare hose assembly for installation or storage per WP003 00 thru WP006 00.

7. Fabricating Hose Assemblies MIL-DTL-8790 With Single Elbow Fitting. To fabricate high pressure synthetic rubber assemblies MIL-DTL-8790 with elbow fittings, proceed as follows:

a. Determine hose length from WP 004 00: Figure 7 and Table 6.

b. Measure hose to required length and cut off square, using cutoff machine.

c. Blow hose clean with filtered shop air after cutting.

d. Using the notch on the socket to determine the amount of outer cover to strip, score the circumference of the hose down to the wire reinforcement (Figure 1).

e. Make an axial (lengthwise) slit to the cutoff end (Figure 1).

f. Pry up a corner of axial slit, using slipjoint pliers, and twist off outer cover down to wire braid (Figure 2).

CAUTION

Do not loosen or break wires when cleaning hoses.

g. Wire brush to remove particles of rubber cover from exposed wire braid (Figure 3).

Gasket Sealing Compound, MIL-S-45180, Type II **3**

h. Using a paint brush, apply a uniform coating of sealant MIL-S-45180, Type II to exposed wire braid (Figure 4).

CAUTION

Do not overtighten vise on thin-walled lightweight fittings.

i. Clamp socket in vise.

j. Screw hose counterclockwise into socket (Figure 5) with a twisting, pushing motion until hose bottoms on socket shoulder.

k. Back out hose 1/4 turn.

Hydraulic Fluid, MIL-PRF-83282 **1**

l. Lubricate inside bore of hose and outer surface of nipple assembly with hydraulic fluid MIL-PRF-83282 (Figure 6).

CAUTION

Do not overtighten vise on thin-walled lightweight fittings

m. Clamp socket with hose in vise.

n. Adjust socket and elbow clearance.

(1) Screw nipple assembly into hose.

(2) Use a wrench on elbow hex. Turn elbow clockwise until elbow hex is within 1/16 inch of socket.

8. Fabricating Hose Assemblies MIL-DTL-8790 With Straight Fitting on One End and Elbow Fitting on the Other End. Paragraphs 5 and 6 provide instructions for a complete hose assembly MIL-DTL-8790 consisting of one straight end fitting and one elbow end fitting.

9. Fabricating Hose Assemblies MIL-DTL-8790 With Double-Ended Elbow Fittings. To fabricate a double-ended elbow assembly, repeat instructions of Paragraph 6 for one end and continue with the following steps:

a. Using the notch on the socket to determine the amount of outer cover to strip, score the circumference of the hose down to the wire reinforcement (Figure 1).

b. Make an axial (lengthwise) slit to the cutoff end (Figure 1).

c. Pry up a corner of axial slit, using slipjoint pliers, and twist off outer cover down to wire braid (Figure 2).

CAUTION

Do not loosen or break wires when cleaning hoses.

d. Wire brush to remove particles of rubber cover from exposed wire braid (Figure 3).

Gasket Sealing Compound, MIL-S-45180, Type II **3**

e. Using a paint brush, apply a uniform coating of sealant MIL-S-45180, Type II to exposed wire braid (Figure 4).

CAUTION

Do not overtighten vise on thin-walled lightweight fittings.

f. Clamp socket in vise.

g. Screw hose counterclockwise into socket (Figure 5) with a twisting, pushing motion until hose bottoms on socket shoulder.

h. Back out hose 1 /4 turn.

Hydraulic Fluid, MIL-PRF-83282 **1**

Hydraulic Fluid, MIL-H-81019 **2**

i. Lubricate inside bore of hose and outer surface of nipple assembly with hydraulic fluid MIL-PRF-83282 (Figure 6).

CAUTION

Do not overtighten vise on thin-walled lightweight fittings

j. Clamp socket with hose in vise.

k. Clamp socket in vise so opposite end of fitting points downward. Make sure hose does not have an axial twist.

l. Adjust elbow and socket clearance.

(1) Screw nipple assembly into hose.

(2) Use a wrench on elbow hex. Turn elbow clockwise until elbow hex is within 1/16 inch of socket.

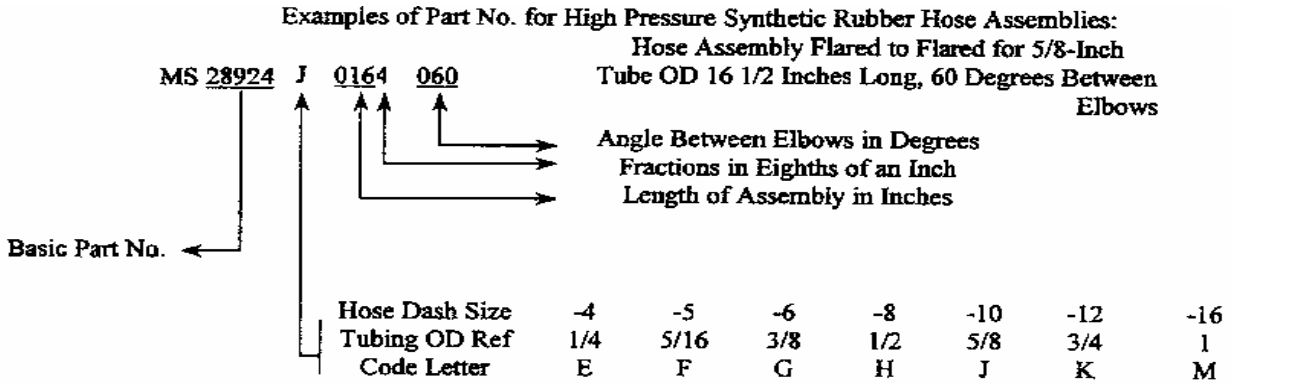
m. Rotate elbow to required angular position.

NOTE

Adjust both elbows to get correct relative angle between the two ends. Except for alignment, backing off for position shall be avoided. If backing off for position is necessary, do not exceed one quarter turn.

n. Clean, inspect, test, identify and prepare hose assembly for installation or storage per WP003 00 thru WP006 00.

Table 1. Synthetic Rubber High-Pressure Hose Assemblies Per MIL-DTL-8790



004t05a

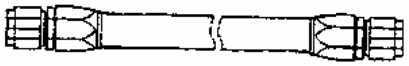
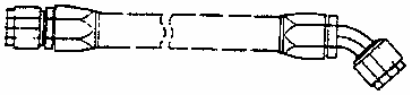
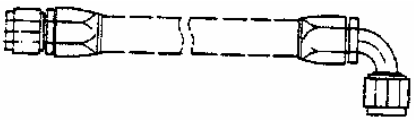
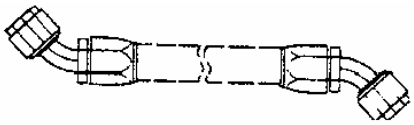
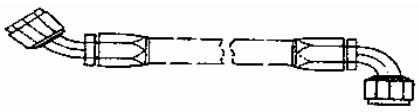
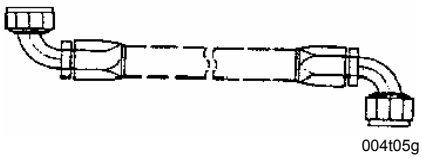
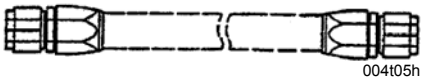
Flared to Flared		Hose Assembly Part No.	Dash Size	Fittings	
A	B			A	B
 004t05b		MS28759	-4 to -16	MS28760	MS28760
 004t05c		MS28920	-4 to -16	MS28760	MS28780
 004t05d		MS28921	-4 to -16	MS28760	MS28781
 004t05e		MS28922	-4 to -16	MS28780	MS28780
 004t05f		MS28923	-4 to -16	MS28780	MS28781
 004t05g		MS28924	-4 to -16	MS28781	MS28781
 004t05h		MS28762	-4 to -16	MS28761	MS28761

Table 2: Performance Characteristics of MIL-DTL-8790 High Pressure Rubber Hose Assembly

Test Condition (Note 1)	-4	-5	-6	-8	-10	-12	-16
Operating Pressure (Note 2)	3000	3000	3000	3000	3000	3000	3000
Proof Pressure (Note 3)	8000	7000	7000	7000	6000	6000	5000
Burst Pressure (Note 3)	16000	14000	14000	14000	12000	12000	10000
Minimum Bend Radius (in.)	3.00	3.38	5.00	5.75	6.50	7.75	9.62

Note 1: Typical operating pressures and burst pressures are included for information purposes only.
Note 2: Pressures are maximum (psi max)
Note 3: Pressures are minimum (psi min)

10. (AIR FORCE ONLY) MACHINE ASSEMBLY METHOD

11. (AF) Tools and Equipment Required.

a. **(AF)** Hose Cutting and Skiving Machine, FSN 4940-012-5866.

b. **(AF)** Hose and Fittings Assembly Machine Model F2152, FSN 4940-601-6985.

c. **(AF)** Hose Line Assembly Machine Model F1766, FSN 4940-212-8040.

12. (AF) Machine Tool Assembly Procedure.

a. **(AF)** Detailed instruction for cutting hose and skiving is furnished in T.O. 34Y30-4-1.

b. **(AF)** Detailed instructions for assembling fittings on hose is furnished in T.O. 34Y30-2-1for Hose and Fitting Assembly Machine, Model F2152. Refer to T.O. 34Y30-3-1 for Model F1766.

c. **(AF)** Supplemental Data.

(1). **(AF)** Improper adjustment when skiving will leave an excessive amount of rubber on the braid or “BURN” the braid. Do not install end fittings on burned braid.

(2) **(AF)** Do not wire brush the cut end of the hose or excessive wire flaring will result.

(3) **(AF)** Stopping of the machine prior to completion of the assembly will, in most cases, cause the nipple threads to seize the rubber and when restarted, cause the rubber innertube to bulge and/or tear loose from the braid.

d. **(AF)** After hose assembly is completed, clean internally using dry compressed air.

e. **(AF)** Visually inspect assembly internally for cuts in innertube.

f. **(AF)** Proof pressure test hose assembly with hydraulic fluid for a minimum of 1 minute and a maximum of 5 minutes. Test per procedures in WP 004 00.

g. **(AF)** Hose assemblies showing no evidence of seepage shall be drained, capped and tagged as serviceable, MS22759 or MS28762, Specification MIL-DTL-8790.

NOTE (AF)

Under no condition will any adjustment of swivel end and hose be made after test and final acceptance of completed hose assembly.

13. (AF) FIRE SLEEVE HOSE ASSEMBLY. Refer to WP 004 00 for general installation procedure of fire sleeve.

14. (AIR FORCE ONLY) HOSE ASSEMBLIES WITH PERMANENTLY ATTACHED END FITTINGS.

15. (AF) General. This section provides general and specific instructions for aeroquip hose assemblies GH493 and GH793 with permanently attached end fittings.

NOTE (AF)

Hose assemblies GH 493 and GH 793 are only authorized for use on support equipment.

16. (AF) Tools and Equipment Required.

a. **(AF)** Hose Cutting and Skiving Machine, FSN 4940-348-4798.

b. **(AF)** Hose Crimp Machine, Aeroquip FT 1340-2-1.

17. (AF) Assembly Procedure.

a. **(AF)** Determine hose length from WP 004 00: Figure 7 and Table 6.

NOTE (AF)

These hoses do not require skiving.

b. **(AF)** Cut hose to desired length.

c. **(AF)** Select proper die cage by matching hose part number and dash size to corresponding color and dash number on die cage (Table 3).

CAUTION (AF)

Make sure the die cage is properly installed or damage to machine or dies may result.

d. **(AF)** With crimp machine cylinder fully retracted, install the crimp die cage by sliding it downward against the pressure plate until the back of the crimp die cage and the bolt on the back of the crimp die cage is seated in the slot at the top of the pressure plate.

e. **(AF)** Lubricate crimp ring where metal to metal contact is made with Anti-Seize compound MIL-A-907E or equivalent (Figure 8).

f. **(AF)** Install fitting on hose until bottomed.

NOTE (AF)

Crimp machine cylinder may be extended to help line up socket scribe mark with die cage.

g. **(AF)** Adjust the fitting locator so that when the assembly is inserted, the socket scribe mark is lined up with edge of the dies (Figure 8).

WARNING (AF)

Keep clear of all moving parts or personal injury may result.

h. **(AF)** Set the cylinder travel encoder to 500, and precrimp the assembly through one complete cycle.

i. **(AF)** Determine the proper crimp diameter (Table 2).

j. **(AF)** Measure precrimp diameter across socket flats. Subtract specified crimp diameter from precrimp diameter.

k. **(AF)** Multiply figure determined in step j by 2.

l. **(AF)** Add figure determined in step k to cylinder travel encoder.

WARNING

(AF)

Keep clear of all moving parts or personal injury may result.

m. **(AF)** Reinsert assembly into crimp machine and crimp assembly through one complete cycle.

n. **(AF)** Ensure crimp diameter falls within specified range (+/- .006”). Adjust encoder as necessary.

NOTE (AF)

Re-determining a precrimp diameter is not necessary for the second end ofthe hose, or for subsequent hoses of the same size on the same run, but it must be accomplished on runs of hoses done at a later time/date.

o. **(AF)** In lieu of the Proof Testing Procedures shown in WP 004 00, use the following:

(1) **(AF)** Determine hose proof pressure (Table 4).

(2) **(AF)** Proof test hose assembly for a minimum of one (1) minute, and a maximum of five (5) minutes using water or hydraulic fluid.

(3) **(AF)** Hose assemblies showing no evidence of seepage will be drained, dried, and cleaned using dry compressed air, capped, identified in accordance with WP 004 00, and tagged serviceable.

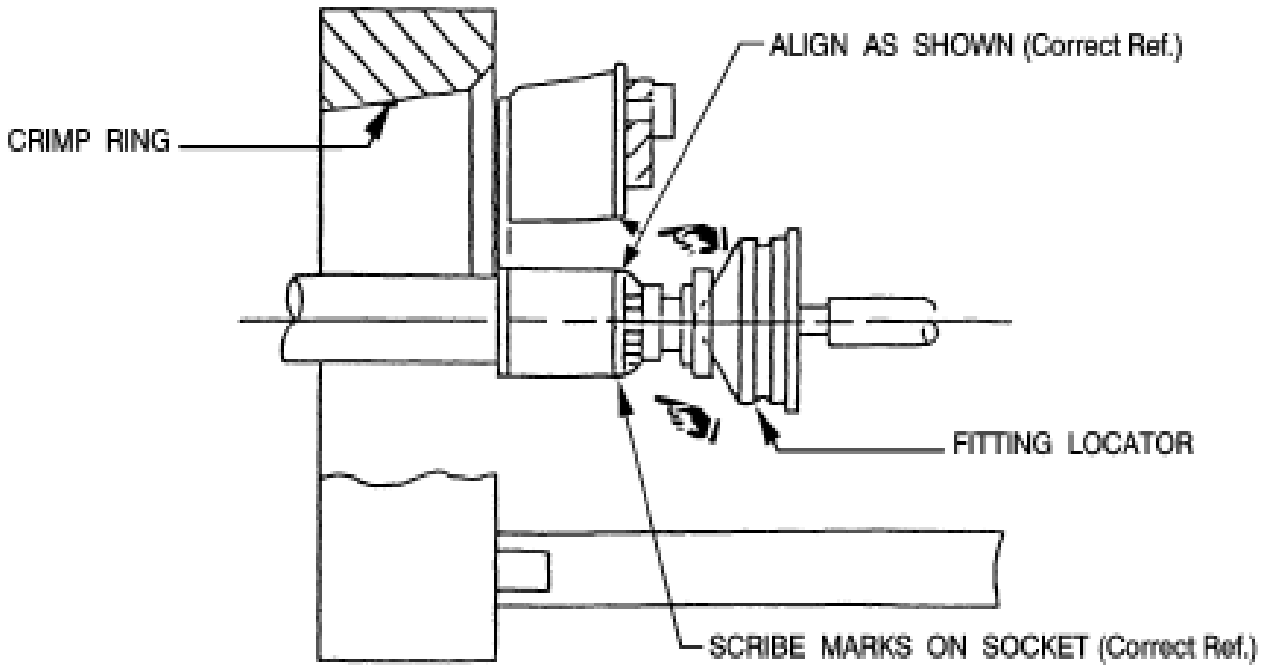


Figure 8. Aligning and Marking Hose

Table 3. Identification of Aeroquip Die Cages & Crimp Specifications

Aeroquip MatchMate Plus Hose Assemblies GH493					
Hose Style	Hose size	Die color	MFR's Crimp Die Cage part number	MFR's Socket Part number	Crimp Diameter +/-.006in
GH493	-6	YELLOW	FT1307-200-M210	TTC12-6	.896in
GH493	-8	YELLOW	FT1307-200-M240	TTC12-8	1.095in
GH493	-10	YELLOW	FT1307-200-M280	TTC12-10	1.200in
GH493	-12	YELLOW	FT1307-200-M320	TTC12-12	1.355in
GH493	-16	YELLOW	FT1307-200-M420	TTC12-16	1.725in
GH493	-20	YELLOW	FT1307-200-M520	TTC12-20	2.055in
GH493	-24	YELLOW	FT1307-200-M550	TTC12-24	2.200in
Aeroquip MatchMate Plus Hose Assemblies GH781					
GH781	-4	GREEN	FT1307200-M150	TTC-4	.665in
GH781	-6	GREEN	FT1307200-M210	TTC-6	.815in
GH781	-8	GREEN	FT1307200-M240	TTC-8	.975in
GH781	-10	GREEN	FT1307200-M280	TTC-10	1.115in
GH781	-12	GREEN	FT1307200-M320	TTC-12	1.245in
GH781	-16	GREEN	FT1307200-M370	TTC-16	1.565in
GH781	-20	GREEN	FT1307200-M465	TTC-20	1.900in
Aeroquip MatchMate Plus Hose Assemblies GH793					
GH793	-4	RED	FT1307-200-M150	TTC-4	.680in
GH793	-6	RED	FT1307-200-M210	TTC-6	.835in
GH793	-8	RED	FT1307-200-M240	TTC-8	.990in
GH793	-10	RED	FT1307-200-M280	TTC-10	1.130in
GH793	-12	RED	FT1307-200-M320	TTC-12	1.280in
GH793	-16	RED	FT1307-200-M370	TTC-16	1.630in
GH793	-20	RED	FT1307-200-M465	TTC-20	1.960in
GH793	-24	RED	FT1307-200-M550	TTC-24	2.270in
GH793	-32	RED	FT1307-200-M690	TTC-32	2.790in

Table 4. Aeroquip Hose Performance Specifications

Aeroquip MatchMate Plus Hose Assemblies GH493								
Hose Style	Hose size	Die color	HOSE I.D."	HOSE O.D."	Oper Press	Proof Press	Burst Press	min/BEND radius
GH493	-6	YELLOW	.38	.79	4,000	8,000	16,000	5.00
GH493	-8	YELLOW	.50	.92	4,000	8,000	16,000	7.00
GH493	-10	YELLOW	.63	1.11	4,000	8,000	16,000	9.50
GH493	-12	YELLOW	.75	1.20	4,000	8,000	16,000	9.50
GH493	-16	YELLOW	1.00	1.48	4,000	8,000	16,000	12.00
GH493	-20	YELLOW	1.25	1.83	3,000	6,000	12,000	16.50
GH493	-24	YELLOW	1.50	2.12	2,500	5,000	10,000	20.00
Aeroquip MatchMate Plus Hose Assemblies GH781								
GH781	-4	GREEN	.25in	.53in	5,750	11,500	23,000	2.00in
GH781	-6	GREEN	.38in	.69in	5,000	10,000	20,000	2.50in
GH781	-8	GREEN	.50in	.81in	4,250	8,500	17,000	3.50in
GH781	-10	GREEN	.63in	.93in	3,625	7,250	14,500	4.00in
GH781	-12	GREEN	.75in	1.10in	3,125	6,250	12,500	4.75in
GH781	-16	GREEN	1.00in	1.42in	2,500	5,000	10,000	6.00in
GH781	-20	GREEN	1.25in	1.65in	2,250	4,500	9,000	8.25in
Aeroquip MatchMate Plus Hose Assemblies GH793								
GH793	-4	RED	.25	.60	5,750	11,500	23,000	4.00
GH793	-6	RED	.38	.75	5,000	10,000	20,000	5.00
GH793	-8	RED	.50	.87	4,250	8,500	17,000	7.00
GH793	-10	RED	.62	.98	3,625	7,250	14,500	8.00
GH793	-12	RED	.75	1.16	3,125	6,250	12,500	9.50
GH793	-16	RED	1.00	1.50	2,500	5,000	10,000	12.00
GH793	-20	RED	1.25	1.92	2,250	4,500	9,000	16.50
GH793	-24	RED	1.50	2.15	1,800	3,600	7,200	20.00
GH793	-32	RED	2.00	2.51	1,500	3,000	6,000	25.00

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

MAINTENANCE

HOSE AND HOSE ASSEMBLY

Reference Material

Hose Assembly, Fabrication WP004 00
Hose and Hose Assembly, Quality Assurance WP006 00
Fuel and Hydraulic System Protective Closures, Description WP007 00

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Record of Applicable Technical Directives

None

1. GENERAL.

2. Maintenance of hose and hose assemblies at the Organizational level is limited to preventive maintenance, contamination control, removal, and installation, or replacement.

3. Observe the following general maintenance practices:

a. Do not use hose or hose assemblies as foot- or handholds.

b. Do not lay hose or hose assemblies where they may be stepped on or run over by vehicles.

c. Do not lay objects on hose or hose assemblies.

d. When loosening or tightening fittings, turn the swivel nut. Hold the socket only to prevent the hose assembly from turning.

e. Before removing any hose or hose assembly, perform all necessary turn-off or shutdown procedures as outlined in the applicable maintenance instruction manuals or technical directives.

f. Cover open ends of hose, hose assemblies, and fittings with protective closures as described in WP007 00.

g. Make sure hose, hose assemblies, and connection points are cleaned before installing.

4. PREVENTIVE MAINTENANCE.

5. Preventive maintenance consists of periodic inspection and correction of hose and hose assembly faults.

6. CHECKING FOR LEAKS.

CAUTION

Excessive torque will cause leaks.

a. Hose or hose assemblies shall be replaced when leaks are caused by the following:

(1) Damage to any part of a hose or hose assembly.

CAUTION

Ensure that system pressure is bled down prior to torque check.

NOTE

If a leak appears in the swivel nut area, check that the swivel nut is properly torqued. If necessary, disconnect fitting and check for contamination or damage. If the leak persists after cleaning, and the swivel nut is properly torqued, replace hose assembly.

(2) Poor seating or damaged threads of socket or nipple assembly which causes fitting to leak.

7. CHECKING FOR WEAR AND DETERIORATION. Check hose and hose assemblies for signs of wear and deterioration as described in WP006 00 and replace any hose or hose assembly showing such signs. In addition to the instructions in WP006 00, check the following:

a. If a chafe guard appears worn or shows signs of cracking, replace chafe guard (WP004 00).

b. If a fire sleeve is worn through, torn, cut, or oil soaked, replace hose or hose assembly.

NOTE

The removed hose or hose assemblies may be recovered with new fire sleeving after determination by cleaning, inspection, and testing that the hose or hose assemblies can be used again.

c. Replace hose or hose assembly that has weather-protective coatings or sleevings which are worn, cracked, or torn, thus exposing the hose or hose assemblies to corrosion.

8. CHECKING HOSE OR HOSE ASSEMBLY INSTALLATIONS. Check hose or hose assembly installations as follows:

CAUTION

A preformed hose or hose assembly may have a smaller bend radius. Do not attempt to straighten preformed hose or hose assemblies.

a. Check for proper routing and clamping in accordance with applicable maintenance instruction manuals.

b. Check for backed-out retaining wires on swivel nuts and presence of lockwire where lockwire is used.

NOTE

If retaining wires on swivel nuts are backed out, replace hose assembly.

c. Check for kinks or twists. Observe lay line, if possible. A kinked hose or hose assembly shall be replaced. A twisted hose or hose assembly may be relieved by loosening clamps and swivel nuts, then straightening the hose by hand. Retorque swivel nuts and tighten clamps.

d. Check for excessive bends or signs of chafing which may be due to loose, oversize, or worn clamps and tighten clamp without squeezing the hose.

9. CHECKING CLAMPS. Clamps shall be checked as follows:

CAUTION

Do not use clamps with fuel-resistant cushioning unnecessarily. Fuel-resistant cushioning material deteriorates rapidly when exposed to air.

a. Check clamps for correct type and size.

b. Check positioning of hose within clamp. Reposition hose and clamp as required.

c. Check positioning of cushion material. Cushion material shall not lodge between end tabs of closed clamp.

10. CORRECTION OR REPAIR. Correction of hose or hose assembly installation faults consists of minor adjustment or replacement. Repair of hose or hose assemblies is not permitted except as directed in emergency conditions by person or persons in command.

11. CONTAMINATION CONTROL.

12. Contamination control procedures consist of the following steps:

a. Using approved solvents (WP004 00) and clean, lint-free cloths, clean the affected area and wipe down fittings to remove excessive contaminants.

b. Use a suitable container to catch spilled fluid.

c. Have replacement hose, hose assemblies, or protective closures (WP007 00) on hand for installation when disconnecting hose or hose assemblies. If hose replacement is not practical, cap or plug hose or hose assembly ends immediately after disconnecting.

13. REMOVAL.

14. Before removing any hose or hose assembly, perform contamination control procedures described in Paragraph 11, and all necessary turnoff and/or shutdown procedures in accordance with the applicable instruction manuals or technical directives. To remove hose or hose assemblies, proceed as follows:

a. Remove all supporting clamps from hose or hose assembly.

b. Remove lockwire, if present, from swivel nuts.

c. Turn swivel nuts only to disconnect hose assembly. Loosen nuts carefully to avoid damage.

d. Disconnect the hose assembly by using two open-end wrenches. One is to grip and prevent turning of the fitting to which the hose assembly is connected, and the other is to loosen the swivel nut.

NOTE

Hose and hose assemblies (particularly PTFE), have a tendency to become set to shape in service. Some PTFE hose assemblies are deliberately preformed during the fabrication process. Do not attempt to straighten preformed hose. Protect the preformed areas from distortion by a restrainer. The restrainer may be wire, metal, plastic forms, or other suitable device to retain the preformed configuration.

e. Install protective closures (WP007 00) to seal open ports of hydraulic lines and ends of removed hose or hose assemblies.

15. INSTALLATION.

Materials Required

Specification or Part Number	Nomenclature
MIL-PRF-83282	Hydraulic Fluid

16. The replacement hose or hose assembly shall be a duplicate of the one removed in length, outside diameter, material, type, contour, and associated markings.

Hydraulic Fluid, MIL-PRF-83282 **1**

Oil of any type shall not be used on self-sealing hose as an aid to installation. Compatible oil, approved for the purpose, may be used on all other types of fuel, oil, and coolant hose installations.

To avoid equipment damage, do not install crush washers.

17. FLUID FOR HOSE OR HOSE ASSEMBLY INSTALLATION. Use only fluid conforming to MIL-PRF-83282 on hydraulic and pneumatic hose installations.

18. INSTALLATION PRECAUTIONS. When installing and handling hose or hose assemblies, take care to prevent injury to hands or damage to hose caused by kinking. The following are examples of kinking situations:

a. A hose that is bent to a smaller radius than specified in Table 1.

b. A preformed hose assembly, or one that has become set-to-shape of operating position, is straightened or handled without a protective restraint.

c. A hose or hose assembly that is twisted during handling, removal, or installation.

19. INSTALLING HOSE OR HOSE ASSEMBLIES. Hose or hose assembly is installed as follows:

a. Check hose or hose assembly before installing (WP006 00).

b. Remove protective closures from hydraulic lines, hose, or hose assemblies.

NOTE

Make sure installation area is clean to prevent system contamination.

c. When possible, install hose or hose assemblies so that identification markings are visible.

d. Install hose or hose assemblies without twisting, chafing, or overbending (Figure 1).

Observe bend radius minimums in Table 1. Greater bend radius is preferred where possible.

e. Install hose or hose assemblies with a slight bow or slack to compensate for contraction pressure on the line (Figure 1).

f. When connecting hose or hose assemblies to an engine or an engine-mounted accessory, provide 1 1/2 inches of slack or a suitable bend between the last point of support and the engine or accessory attachment.

Table 1. Bend Radius Data

Rubber Hose (Note 1)								Teflon Hose			
Low-Pressure MIL-H-5593		Medium-Pressure MIL-H-8794		Medium-Pressure Light-Weight MIL-H-83797		High-Pressure MIL-H-8788		Medium-Pressure MIL-H-27267		High-Pressure MIL-H-83298	
Hose Dash No.	Minimum Bend Radius (Inches)	Hose Dash No.	Minimum Bend Radius (Inches)	Hose Dash No.	Minimum Bend Radius (Inches)	Hose Dash No.	Minimum Bend Radius (Inches)	Hose Dash No.	Minimum Bend Radius (Inches)	Hose Dash No.	Minimum Bend Radius (Inches)
-2	2.00	-2	—	-2	—	-2	—	-2	—	-2	—
-3	2.00	-3	3.00	-2	1.75	-3	—	-3	2.00	-3	—
-4	4.00	-4	3.00	-4	2.00	-4	3.00	-4	2.00	-4	3.00
-5	—	-5	3.38	-5	2.25	-5	3.38	-5	2.00	-5	—
-6	4.00	-6	4.00	-6	2.50	-6	5.00	-6	4.00	-6	5.00
-8	6.00	-8	4.62	-8	3.50	-8	5.75	-8	4.62	-8	5.75
-10	6.00	-10	5.50	-10	4.00	-10	6.50	-10	5.50	-10	6.50
		-12	6.50	-12	4.50	-12	7.75	-12	6.50	-12	7.75
		-16	7.38	-16	5.50	-16	9.62	-16	9.00	-16	9.62
		-20	9.00	-20	8.00					-20	12.00
		-24	11.00	-24	9.00	16Z (Note 2)	7.38	16Z (Note 2)	7.38		
		-32	13.25	-32	12.50	20Z (Note 2)	11.00	20Z (Note 2)	11.00		
		-40	24.00			24Z (Note 2)	14.00	24Z (Note 2)	14.00		
		-48	33.00								

Notes: 1. Bend Radius for MIL-DTL-6000 and MIL-H-7938 hose shall not be less than 12 times the inside diameter of the hose.
2. Z - Designated two stainless steel wire braids.

Table 1. Bend Radius Data (Cont)

PTFE High Temperature, High Pressure			
AS604 Heavy Braid		AS1339 Lightweight	
Hose Dash No.	Minimum Bend Radius (Inches)	Hose Dash No.	Minimum Bend Radius (Inches)
-04	3.00	-04	1.50
-06	5.00	-06	2.50
-08	5.75	-08	2.88
-10	6.50	-10	3.25
-12	7.75	-12	4.00
-16	9.63	-16	5.00
-20	12.00	-20	—

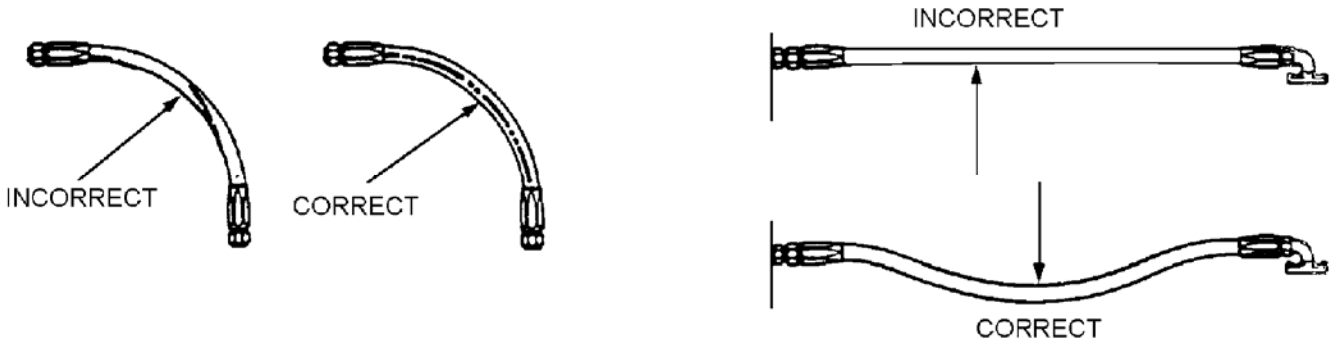


Figure 1. Hose Assembly Installation

CAUTION

Before applying final torque to end fittings, make sure hose assemblies are properly aligned and free of twists and kinks.

g. Finger-tighten swivel connector nuts to avoid stripping threaded areas of fittings. Complete tightening by using torque values specified in applicable maintenance instruction manuals. Table 2 is a guide for installation torque of flared and flareless fittings.

h. Hold fitting stationary with one wrench, and use torque wrench to tighten swivel nut.

i. When applying final torque, hold hose manually to prevent rotation and scoring of the fittings sealing surface.

j. Lockwire the swivel nut (if applicable).

20. CLAMPING HOSE OR HOSE ASSEMBLIES. Route and clamp hose or hose assembly securely to avoid abrasion and kinking where flexing occurs (Figure 2).

CAUTION

Overtightening clamps will squeeze or deform hose.

a. Cushion-type clamps shall be used to prevent hose chafing (Table 2).

b. Clamps may be reused if they meet the following conditions:

(1) They are the correct size.

(2) Cushioning is intact and resilient.

(3) Metal is not deformed.

(4) Metal does not show cracks or scoring that indicate bending fatigue.

c. Clamps shall support hose or hose assemblies at 24-inch intervals or closer where possible and fit snugly around outside diameter of hose.

Table 2: Cushion Support Clamp Sizes

Hose Dash Size	601 Hose MS21919	601 Hose with 624 firesleeve MS 21919	Hose Assemblies MIL-H-25579	Teflon Chafe Guard	
				Aeroquip PN	Resistoflex PN
-3	-6	-11	5	656-1	
-4	-7	-12	6	656-2	R5400-.460
-5	-8	-13	7	656-3	R5400-.520
-6	-9	-15	8	656-4	R5400-.595
-8	-11	-17	10	656-6	R5400-.715
-10	-13	-19	11	656-9	R5400-.810
-12	-16	-22	13	656-10	R5400-.955
-16	-19	-26	18	656-15	R5400-1.230
-20	-23	-32	22	656-18	R5400-1.550
-24	-27	-41	27		
-32	-34				

21. SUPPORTING FLEXIBLE HOSE OR HOSE ASSEMBLIES. Flexible hose or hose assemblies shall be supported to prevent deflection of rigid connecting assemblies as follows:

a. Eliminate chafing against structure, moving parts, or other assemblies by clamping and by using chafe guards.

b. Make sure support clamps do not restrict hose travel or subject hose or hose assembly to tension, torsion, compression, or sheer-stress during flexing cycles.

c. Where flexing is required in an installation, bend the hose in the same plane of movement to avoid twisting as follows:

(1) For hose flexing in two directions, clamp hose at point where the hose changes planes.

(2) For hose assemblies required to flex at a bend, the minimum bend radius is greater by a factor of “N” than the minimum bend radius for a non-flexing hose (Figure 3).

22. PROTECTING HOSE OR HOSE ASSEMBLIES FROM HEAT. Protect hose and hose assemblies from excessive temperatures such as exhaust blasts and supercharged ducts. Locate hose or hose assemblies as far as possible from the heat source, or by the use of firesleeving described in WP004 00.

23. CHECKING HOSE AND HOSE ASSEMBLY INSTALLATIONS. When a hose or hose assembly installation is completed, check the installation and system as follows:

a. Correct fluid level.

b. Proper operation in accordance with applicable maintenance instruction manual.

c. Fluid leaks during operation.

d. Quality assurance provisions in WP006 00.

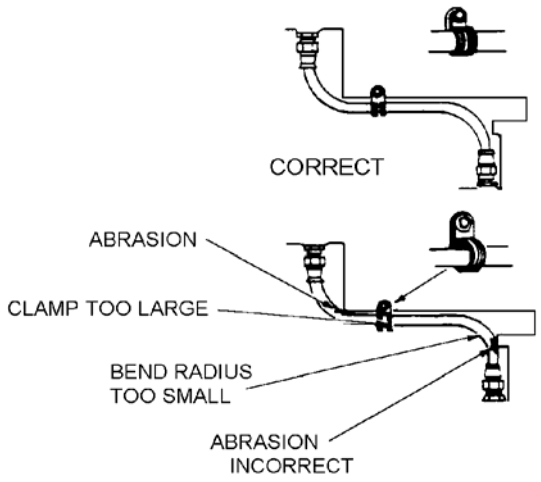
24. REPLACEMENT.

25. Hose or hose assemblies subject to age controls or service life (WP006 00) shall be listed in the appropriate section of the rework specification. Hose or hose assemblies shall be replaced at the time of standard rework of the aircraft, if service life will expire before completion of the next tour of duty.

Table 3. Swivel Nut Installation Torque (Inch-Pound) for Flared and Flareless Fittings

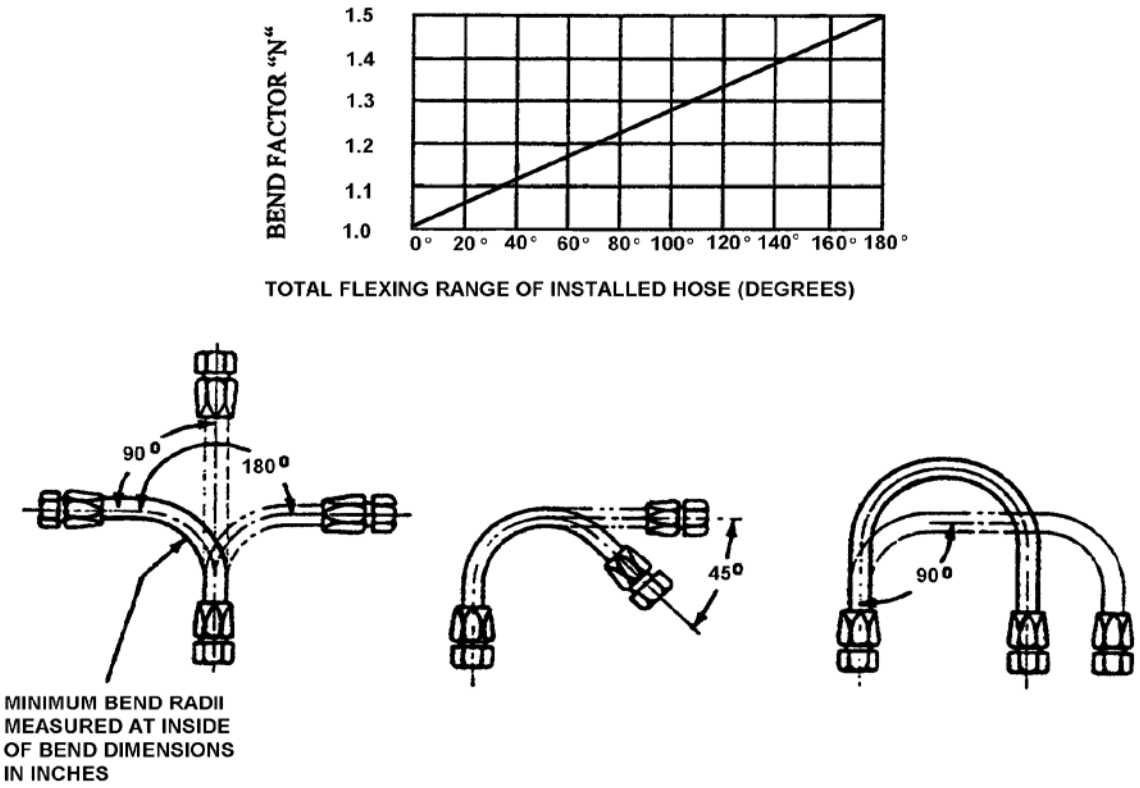
Hose Size	Steel (Note 1)		Aluminum (Note 1)	
	Min.	Max.	Min.	Max.
2	75	85	20	30
3	95	105	25	35
4	135	145	50	65
5	170	190	70	90
6	215	245	110	130
8	430	470	230	260
10	620	680	330	360
12	855	945	460	500
16	1140	1260	640	700
20	1520	1680	800	900
24	1900	2100	800	900
32	2660	2940	1800	2000

Notes 1. Torque values based on lubrication with fluid MIL-PRF-83282 prior to installation.



005002

Figure 2. Hose Clamp Mounting



NOTE:

1. MINIMUM BEND RADIUS OF HOSE UNDER FLEXING CONDITIONS = "N" X BEND RADIUS OF HOSE WITH NO FLEXING

   EXAMPLE: FOR MIL-H-8788 HOSE OF -6 SIZE REQUIRED TO FLEX OVER A RANGE OF 90 DEGREES, THE MINIMUM BEND RADIUS = 1.25 X 5.0 = 6 1/4 INCHES (MEASURED AT INSIDE OF BEND).

005003

Figure 3. "N" Factor for Flexing Bends

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

QUALITY ASSURANCE, INSPECTION, AND STORAGE

HOSE AND HOSE ASSEMBLY

Reference Material

Hose and Hose Assembly, Maintenance WP005 00
Fuel and Hydraulic System Protective Closures, Description WP007 00
Standard Practice for Military Marking MIL-STD-129

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Record of Applicable Technical Directives

None

1. GENERAL.

2. Hose and hose assemblies fabricated or serviced per the provisions of this manual are subject to inspections, age control, and service life.

Excessive torque will cause leaks.

3. QUALITY ASSURANCE.

4. Inspection is mandatory before, during, and after fabrication or installation. In-service inspections are made on a periodic basis per applicable Maintenance Instruction Manuals (MIMs), Maintenance Requirement Cards (MRCs), and Depot specifications.

5. FABRICATION INSPECTIONS. Fabrication inspections consist of inspecting bulk hose, end fittings and fabricated hose assemblies.

6. Inspecting Bulk Hose. Bulk hose shall be inspected for the following:

a. Proper type and size.

b. Aging - signs of deterioration such as cracks, discoloration, hardening, weather checking, or fungus.

c. Mutilations - mandrel joints, abrasions, seams, nicks or cuts.

d. Braid - two or more broken wires per plait, or more than six broken wires per linear foot.

e. Kinks - inspect for broken wires where kinking is suspected.

f. Plies - any separation of covers or braids from inner tube, or from adjacent covers or braids.

g. Flaring or fraying of braid.

h. Distortions - blisters, bubbles, or bulging.

i. Cut - shall be square, and hose shall be free of cutting residue and obstructions.

j. Corrosion - hose which has carbon steel wire braid is subject to corrosion which may be detected as brownish rust coloration penetrating the outer braid or visible at the cut ends.

NOTE

Corrosion should not be confused with the tendency of stainless steel to turn a yellow-golden to brown color with age and high temperature. This type of discoloration is acceptable if not extreme or localized, indicating possible heat damage to inner tube.

7. Inspecting End Fittings. End fittings shall be inspected for the following:

a. Proper type and size.

b. Corrosion and cleanliness.

c. Nicks, scratches or other damage to the finish, affecting corrosion resistance.

d. Damage to threaded areas.

e. Damage to cone-seat sealing surfaces.

f. Damage to flange fittings - warping of flange, nicks or scratches on the sealing surface or damage to gasket.

8. Inspecting Fabricated Hose Assemblies. Fabricated hose assemblies shall be inspected for the following:

a. Defects listed above.

b. Evidence of internal restriction of tube due to collapse, kinking, wirebraid puncture, or other damage, using one of the following methods of inspection:

(1) For straight hose assembly, insert a light at one end and visually inspect from opposite end.

(2) For elbow fitting on one end, insert flexible inspection light into elbow fitting and visually inspect from straight end.

(3) For elbow fittings on both ends, (practical for larger sizes only) insert flexible inspection light into one end and visually inspect from opposite end, using a small, angled, dental type mirror.

c. Identification bands and protective closures as required after proof pressure testing.

d. Etch serial number of corresponding ground support equipment on hose collars of all external hoses.

9. INSTALLATION INSPECTIONS. Installation inspections include inspection of new, replaced, or reinstalled hose or hose assemblies or used hose or hose assemblies.

10. Inspecting New, Replaced or Reinstalled Hose or Hose Assemblies. Inspect hose or hose assemblies for the following:

a. Proper type, length, and fittings.

b. Defects as listed above and where applicable.

c. Backed-out retaining wires on swivel nuts.

d. Proper gap between nipple hex and socket (maximum gap is 1/16 inch).

11. Inspecting Used Hose or Hose Assemblies. Inspect used hose or hose assemblies for the following:

a. Defects listed above, where applicable.

b. Abrasions and signs of chafing which may indicate improper support of hose or hose assembly installation.

c. Extreme discolorations of braid or burnt rubber coating which may indicate improper shielding from hot spots.

12. Etch serial number of corresponding ground support equipment on hose collars of all external hoses.

13. INTERNAL INSPECTION. Inspect internally for evidence of tube restriction due to collapse, wire braid puncture, or other damage.

a. Straight Hose Assemblies. Insert light at one end and inspect by looking through from the opposite end.

b. Hose Assembly with Elbow Fitting at One End. Insert flexible inspection light into elbow fitting and examine by looking through from the opposite end.

c. Hose Assemblies with Elbow Fittings at Both Ends. Insert flexible inspection light into one end and examine from opposite end using a dental type mirror. This procedure is practical on large size hose assemblies only.

d. Other Configuration and small Size Hose Assemblies. Pass a ball of proper size (Table 1) through the hose assembly to check for restriction or kinking.

Table 1: Inspection Ball Size Chart

Hose Dash Size	Ball Size (Inches)
-4	3/32
-5	9/64
-6	13/64
-8	9/32
-10	3/8
-12	½
-16	47/64
-20	61/64
Note These are standard master ball sizes	

See IRAC #7

14. (AIR FORCE ONLY) NON-AIRBORNE HOSES. Non-airborne hoses installed on Aerospace Ground Equipment with frayed outer cotton braid or the rubber cover of metal-reinforced hose abraded in small areas, and the metal reinforcement is not exposed or damaged, may be removed from equipment and proof tested. Those hoses which satisfactorily pass the proof test may be repaired as in paragraph 15 and reinstalled on equipment. Repaired hoses shall be proof tested annually.

See IRAC #7

15. **(AF)** Frayed or chafed areas of non-airborne hoses may be repaired by wrapping the areas in teflon spiral chafe guard. Hoses with sizes 1/4” to 5/8” OD use Part No. 900628-4, NSN 9330-00-027-3345. Hoses with sizes 3/4” and up use Part No. 900628-10, NSN 9330-00-836-8493. Teflon spiral chafe guard will be secured over the hose by use of TY WRAP, Part no. MS3367-1-9, NSN 5975-00-074-2072 or shrink tubing NSN 5970-00-781-6836.

See IRAC #7

16. IN-SERVICE INSPECTIONS. Inspect in-service hose or hose assemblies and installations for the following:

a. Defects as listed above, where applicable.

b. Cold flow as indicated by deep permanent folds, impressions, and cracks produced by clamps or supports.

c. Leakage around fittings and seepage which may be due to cracks in the inner tube.

d. Twists or kinks which may indicate improper installation and incorrect pressures.

e. Proper bend radii as shown in WP005 00.

f. Routing and clamping shall conform with applicable maintenance instruction manuals and the use of correct type and size clamps.

g. Metal clamps shall have no breaks or cracks. Cushioning must be intact and properly positioned.

h. Restrain hose or hose assemblies with clamps that are not over tightened, or causing strain on the hose, hose assembly, or components during any operating condition.

i. Fire sleeves or chafe guards which are worn through, oil soaked, torn or cut.

j. Etch serial number of corresponding ground support equipment on hose collars of all external hoses.

17. AGE CONTROL AND SERVICE LIFE.

18. Hose or hose assemblies fabricated from age-sensitive materials are subject to age control.

19. DEFINITIONS. The following definitions are provided to clarify age control and service life:

a. Age Control. The efforts made during manufacture, purchase, and storage of age-sensitive items and parts made from natural or synthetic (elastomeric) materials to assure conformance to applicable material and performance specifications. Age control is further defined in terms of acceptance life and shelf life.

b. Acceptance Life. The period of time from cure date to date of delivery to or acceptance by the procuring activity (Organizational, Intermediate, or Depot level activity).

c. Shelf Life. The period of time from date of acceptance or delivery by Organizational, Intermediate, or Depot level activity to date of use.

d. Service Life. The period of time from date of installation to date of removal. Installation date of hose and hose assemblies shall be identified by a tag (Work Package 004 00, Figures 1 and 2).

NOTE

Hoses and hose assemblies made from PTFE do not have shelf life limitations.

20. SHELF LIFE AND ACCEPTANCE LIFE FOR SYNTHETIC RUBBER HOSE AND HOSE ASSEMBLIES.

a. Shelf Life: Synthetic rubber hose, bulk or assembly, shall have a shelf life not to exceed ten years (40 quarters) from the cure date.

b. Acceptance Life: There shall be no less than 85% (34 quarters) of the shelf life remaining upon receipt at the first government activity receiving the material from the manufacturer.

21. CURE, ASSEMBLY AND SERVICE DATE MARKINGS. Cure date, assembly date, and installation date are indicated by quarter of the year and year. A year is divided into four quarters as follows:

1st Quarter - January, February, March
2nd Quarter - April, May, June
3rd Quarter - July, August, September
4th Quarter - October, November, December

NOTE

Synthetic rubber hose and hose assemblies manufactured or installed during any given quarter are not considered one quarter old until the end of the succeeding quarter.

22. CURE DATE OF HOSES. Age control (acceptance date) of synthetic rubber hoses is based on the cure date. Cure date is marked on bulk hose containers in accordance with MIL-STD-129, indicating the applicable quarter of the year and the year. Example: hoses cured in June 2003 will be marked 2Q03.

23. ASSEMBLY DATE OF HOSE ASSEMBLY. Assembly date shall indicate the letter A followed by the quarter of the year, the letter Q, and ended with the last two digits of the year. Example: hose assemblies fabricated during June 1997 will be marked A2Q97. When a decal or band is used which states assembly date, the A may be omitted. Assembly date information is also indicated on unit, intermediate, and shipping containers containing a single item. Exterior shipping containers containing major assemblies made up of two or more assemblies with rubber items are identified by the oldest assembly in the container.

24. SERVICE LIFE FOR AIRCRAFT HOSE ASSEMBLIES. Service life for aircraft hose assemblies is on condition or hard-time replacement as defined by the Maintenance Engineering CFA. These requirements shall be in PMRCs, SDLM, SPO specifications and other applicable maintenance directives.

25. SERVICE LIFE FOR SUPPORT EQUIPMENT HOSE ASSEMBLY.

a. PTFE hose assemblies shall be replaced only on a conditional basis.

b. Replacement of synthetic rubber hoses shall be done in accordance with the applicable MIMs, MRCs and Depot Level Specifications. If replacement criteria is not specified in any of the listed sources, inspect per Paragraph 8 of this Work Package and replace all hoses which fail inspection.

c. All synthetic rubber hose use in support of all Gas Turbine Engine Test Systems (GTETS) shall have a three (3) year service life (Forced Removal Date). GTETS includes all TurboJet/Fan, TurboShaft, TurboProp, and APU systems. This also includes all of the Engine Adapter Assembly (EAA) components. This applies to both indoor and outdoor GTETS plus their EAA's. Any repaired hose assemblies used in a GTETS Facility also requires a three (3) year service life. Due to long lead times from supply on some hose sizes and lengths, local extensions may be requested via the TYCOM for thirty (30) days with a physical inspection per Paragraph 19. Prior to any further 30 day extensions, a pressure test of the material shall be required based on material working limits.

26. STORAGE.

27. Hose or hose assemblies shall be stored as follows:

Do not store hose or hose assemblies in piles.

28. HOSE OR HOSE ASSEMBLIES FABRICATED FROM AGE-SENSITIVE MATERIALS. Hose or hose assemblies fabricated from age-sensitive materials are subject to deterioration by oxygen, ozone, sunlight, heat, moisture, or other environmental factors. These hoses shall be stored in a dark, cool, dry place protected from circulating air, sunlight, fuel, oil, water, dust, and ozone. Ozone may be generated in any atmosphere where electricity is discharged through oxygen or ambient air.

29. METHOD OF STORAGE.

a. Seal both ends of bulk hose. Cap or plug each hose or hose assembly as described in WP007 00.

b. Store hose or hose assemblies on racks which support and protect hose and hold assemblies.

c. Store hose or hose assemblies so that oldest items are issued first.

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION

FUEL AND HYDRAULIC SYSTEM PROTECTIVE CLOSURES

NAVY USE ONLY

Reference Material

Aviation Hydraulics Manual.....NAVAIR 01-1A-17
Cap and Plug, Protective, Dust and Moisture Seal.....NAS 847

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Record of Applicable Technical Directives

None

1. GENERAL.

2. Contamination caused by entry of foreign matter into open lines and parts of hydraulic and fuel system equipment is hazardous and expensive. To protect hydraulic and fuel systems from contaminants, use protective closures. Refer also to NAVAIR 01-1A-17 Work Package 014.

3. PROTECTIVE CLOSURE APPLICATIONS.

CAUTION

In all cases where there is a choice between an internal or external installation, use the external type of closure. Never blank off openings with wooden plugs, paper, rags, tape, or other unauthorized devices.

4. Guidelines for selection and use of protective closures for hydraulic equipment are as follows:

a. Use caps and plugs of the proper size and material.

b. Use closures of metal construction conforming to specifications listed in Table 1 for sealing hydraulic and fuel system equipment, lines, tubes, accessories and components unless excepted in Paragraph 7.

c. Plastic closures may be used to seal electrical fittings and receptacles or other nonfluid openings where contamination is not considered a problem.

d. Use metal protective closures to seal open ports of all hydraulic and fuel lines and accessories.

e. Use metal protective closures to seal new and reusable hydraulic tubing and hose assemblies.

f. Keep all protective closures clean, sorted by size, properly identified, and stored in readily accessible bins.

g. Check protective closures visually for cleanliness, thread damage, or sealing deformation before using.

h. Rubber, plastic, or unthreaded-type protective closures designed to fit over open ends of bulk hose and tubing shall be used in accordance with design function only. Do not use this type of protective closure as a plug for insertion into open lines, hoses, or ports of hydraulic equipment.

i. Remove protective closures before installing equipment. If an opening normally requiring protection is found uncovered, the part or assembly shall be cleaned and checked before installation of assembly.

5. PROTECTIVE CLOSURE DESCRIPTION.

6. Two types of protective metal closures are approved for sealing hydraulic equipment. They are caps and plugs conforming to appropriate military specifications (Table 1).

7. POLYETHYLENE PROTECTIVE CLOSURES. Metal protective closures are preferred for Rosan and Dynatube fittings, but may not be readily available. High density polyethylene protective closures may be used as an alternate closure as a dust cap. Do not use the high density polyethylene protective closure to contain fluid. Dynatube fittings shipped from Resistoflex Corporation to Navy Supply conforming to the above requirements may be reused, provided they are clean and properly stored.

8. BLANKOFF PLATES. Blankoff plates (Figure 1) are used as follows:

CAUTION

Do not use fiber, plastic, or masonite blankoff plates where pressure or retention of hydraulic fluid is required.

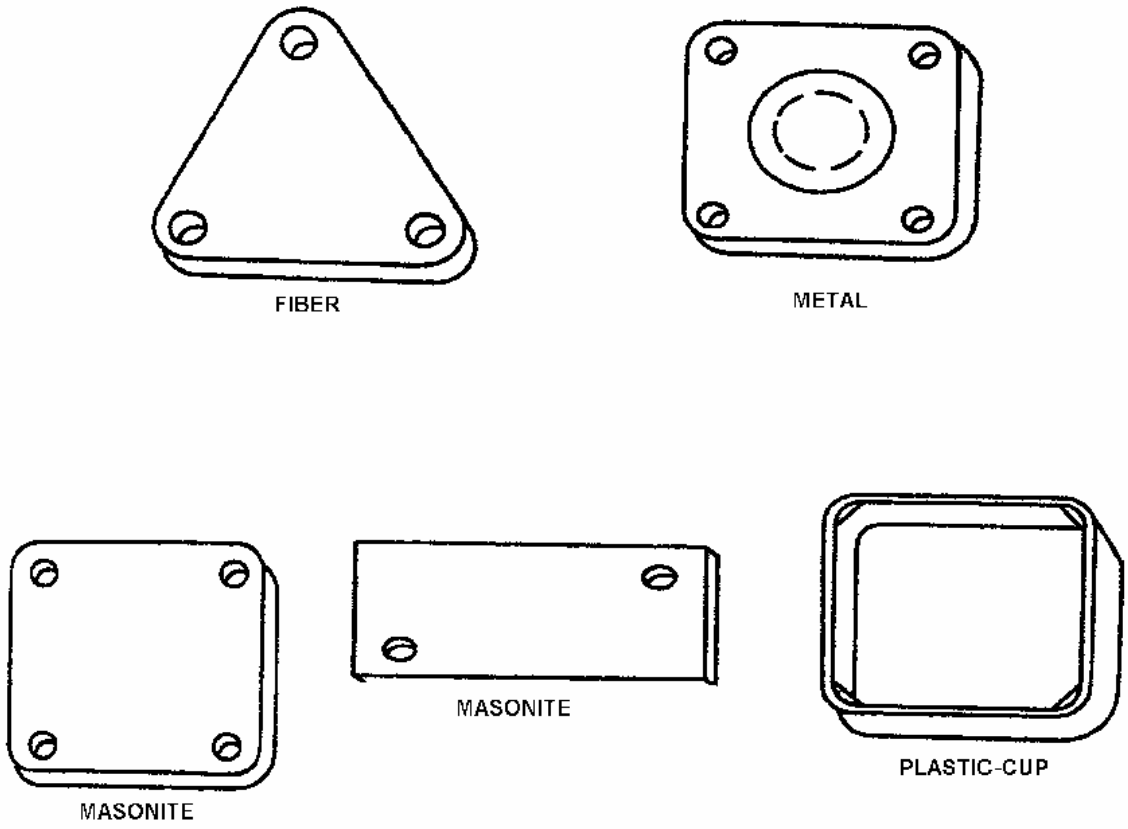
a. Use blankoff plates to seal and protect flange-type connections.

b. Use a gasket and metal plate where retention of hydraulic fluid is required.

c. If plastic blankoff plates are used, plastic material shall conform to NAS 847.

Table 1. Protective Caps and Plugs

Type	Application	Applicable Specification
Cap	Flared Fitting	NAS 847 (Preferred) or NAS 817
Cap	Beaded Hose Connection	NAS 847
Cap	Pipe Thread	NAS 847
Cap	Assembly, Pressure Seal, Flared Tube Fitting	AN929
Cap	Pressure Seal, Flareless Tube Fitting	AS 21914
Plug	Flared Tube End and Straight Threaded Boss	NAS 847 (Preferred) or NAS 818 or AN5168
Plug	Flareless Tube End	NAS 847 (Preferred) or AS 21913
Plug	Flared Tube, Precision-Type	AS 5168
Plug	Pipe Thread	NAS 847
Plug	Bleeder, Screw Thread	AS 5169
Plug	Machine Thread, O-Ring Seal	MS9015
Plug	Machine Thread, AMS 5646 Preformed Packing	MS9404
Plug	Bleeder, Screw Thread, Precision-Type	AS 5169
	NOTE When ordering from supply, be sure to order metal caps or plugs.	



007001

Figure 1. Typical Blankoff Plates

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION

TUBING, TUBE ASSEMBLIES, AND FITTINGS

Reference Material

Aluminum Alloy Tubing, Hydraulic, Seamless, Drawn, Round (6061-T6) ..... SAE AMS 4083
Introduction WP002 00
Hoses, Hose Assemblies, and Hose Fitttings, Description WP003 00
Nickel Alloy, Corrosion and Heat-Resistant, Sheet, Strip, Foil and Plate ..... SAE AMS 5896
Steel, Corrosion and Heat Resistant, Seamless and Welded Hydraulic Tubing ..... SAE AMS 5569
Steel, Corrosion and Heat Resistant, Seamless and Welded Hydraulic Tubing ..... SAE AMS 5584
Steel, Corrosion and Heat Resistant, Seamless or Welded Hydraulic Tubing ..... SAE AMS 5897
Steel, Corrosion and Heat Resistant, Welded and Drawn or Seamless and Drawn Tubing ..... SAE AMS 5561
Steel, Corrosion Resistant, Welded Tubing ..... SAE AMS 5565
Steel Tubing, Seamless or Welded, Corrosion Resistant ..... SAE AMS 5567
Titanium Alloy Tubing, Seamless, Hydraulic 3Al - 2.5V ..... SAE AMS 4945
Tube, Aluminum Alloy, Drawn, Seamless WW-T-700/4
Tube, Aluminum Alloy, Drawn, Seamless, 1100 ..... WW-T-700/1
Tube, Aluminum Alloy, Drawn, Seamless, 6061 ..... WW-T-700/6
Tube, Aluminum Alloy, Seamless, Round, Drawn, 6061 Aircraft Hydraulic Quality ..... SAE AMS-T-7081
Tubing, Steel, Corrosion and Heat Resisting (18-8 Stabilized, Welded) ..... SAE AMS 5575
Tubing, Steel, Corrosion and Heat Resisting (18-8 Stabilized, Welded) ..... SAE AMS 5576
Tubing, Steel, Corrosion Resistant (18-8 Stabilized and Extra Low Carbon) MIL-T-8606
Tubing, Steel, Corrosion Resistant (18-8 Stabilized), Aircraft Hydraulic Quality MIL-T-8808
Tubing, Steel, Corrosion Resistant (304), Annealed, Seamless and Welded ..... SAE AMS-T-8506
Tubing, Steel, Corrosion Resistant (304), Aerospace Vehicle Hydraulic Systems MIL-T-8504
Tubing, Steel, Corrosion Resistant (304), Cold Drawn MIL-T-5695
Tubing, Steel, Corrosion Resistant (S30400), Aerospace Vehicle Hydraulic System 1/8 H ..... SAE AMS-T-6845

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Record of Applicable Technical Directives

None

1. TUBING.

2. Tubing is manufactured in accordance with Military, commercial, or Federal specifications (Tables 1 and 2). The most common types of tubing are titanium alloy, the Corrosion-Resistant Steel (CRES) alloys, and aluminum alloys. Tubing is available in a wide range of nominal OD and wall thickness combinations. Selection of the appropriate material, nominal OD, and wall thickness combination is crucial and specific to its intended application and usage.

3. CORROSION RESISTANT STEEL TUBING. (Table 1) CRES tubing is used in high-pressure hydraulic systems (3000 psi and above) such as landing gear, wing flaps, and brakes. It is preferred that external brake lines be made of stainless steel components (tubing, sleeves, nuts) to prevent damage caused by flying gravel and stones and ground handling accidents. In other systems where stainless steel tubing is employed (regardless of tube size) it is preferred that only stainless steel nuts be employed. This will minimize sleeve and nut cracking which may be induced by over torque of "B" nuts and vibration. CRES tubing does not have to be annealed for flaring or forming; in fact, the flared section is strengthened by cold working and consequent strain hardening. Table 1 lists the most commonly used CRES tubing in military aircraft. Included are some of the designations by which the CRES tubing is known. Application notes are intended as guidelines. The high tensile strength of stainless steel tubing permits the use of thinner walls than those of aluminum alloy tubing. Therefore the weight is about the same as thicker walled aluminum alloy tubing. Refer to Tables 5 and 6 for standard dimensions of steel tubing.

4. ALUMINUM ALLOY TUBING. (Table 2) Aluminum alloy tubing is used for both high-pressure and general purpose lines ; however, it is limited in certain areas of airborne hydraulic systems by SAE AS 5440. Refer to the applicable drawing and the illustrated parts breakdown to determine the correct tubing for a particular system. Aluminum alloy tubing is easily flared and is soft enough to be formed with hand tools. It should be handled with care to prevent scratches, dents, and nicks. Aluminum alloy tubing is used with either of two types of connections : the flared joint for mechanical connectors of the beaded end for use with clamps and flexible hose connections. Refer to Tables 7 through 10 for standard dimensions of Aluminum Alloy tubing.

5. TITANIUM ALLOY TUBING. Titanium alloy 3AL-2.5V tubing per Table 3 is presently being incorporated into new model aircraft. Repair and fabrication of assemblies using these materials may require special procedures. Refer to applicable maintenance directives for specific details.

NOTE

Titanium tubes and fittings in Naval aircraft are subject to corrosion attacks. The reagents are chlorine gas from chlorine storage tanks or bleaching powder, hydrochloric acid from rust removers, pickling solutions, or floor cleaners, and sulfuric acid from batteries. These reagents attack titanium parts at various speeds, degrees, and temperatures.

6. TUBE ASSEMBLIES.

7. Tube assemblies are fabricated from rigid tubing and associated fittings to transport fluid or gas (usually under pressure) between various components of the aircraft system.

8. TUBE ASSEMBLY APPLICATIONS. Tube assemblies fabricated with aluminum alloy, CRES, and titanium tubing are used in aircraft for fuel, oil, oxidizer, coolant, breathing oxygen, instruments, hydraulic, and vent lines.

9. Aluminum Alloy Tube Assemblies.

When making permanent repairs or replacing aluminum alloy tube assemblies, the use of tube assemblies manufactured in accordance with the manufacturer's drawing are preferred. Aluminum alloy tubing 6061-T6 is regarded as high strength and may be used as a permanent repair/replacement for lower strength aluminum alloys. Use only the methods in this manual to replace or repair tube assemblies with aluminum alloy tubing 6061-T6. Repair or replacement of aluminum alloy tubing using 6061-T6 is considered permanent.

Replacement of Standard O-rings and/or backup with crush washers is un-authorized.

Aluminum alloy tube assemblies fabricated with aluminum alloy tubing 6061-T6 are authorized repair or replacement for any aluminum line.

NOTE

CRES tubing AMS-T-6845 (304-1/8H) is a suitable substitute for all aluminum alloy tubing when 6061-T6 is unavailable. This does not apply to aluminum alloy low pressure LOX systems.

Replacement tubing for low pressure liquid oxygen systems shall be aluminum alloy only.

10. Corrosion Resistant Steel Tube Assemblies. CRES tube assemblies fabricated with CRES tubing AMS-T-6845 are authorized for repair or replacement for any line, provided no attempt be made to weld or braze tubing AMS-T-6845, and tubing AMS-T-6845 is not substituted for British annealed stainless steel tubing DTD-5016, CRES 21-6-9 per AMS 5561, or Ti 3Al-2.5V CWSR 105 per Boeing MMS 1205. Authorized tubing substitutes are listed in Table 4.

11. TUBE FITTINGS.

12. Fittings for tube connections are made of aluminum alloy, titanium steel, CRES, brass, and bronze. Fittings are made in many configurations and styles. The usual classifications are flared-tube fittings, flareless tube fittings, brazed, welded, and swaged fittings (Figure 1 through 4). Do not replace O-ring and/or backup ring with crush washer. Refer to WP003 00, Table 2 for identification of fittings.

Table 1. Corrosion Resistant Steel Tubing

Specification Tubing Material	Type	Condition	General Usage and Applications
AMS-T-8506 18-8 Corrosion-Resistant Steel (CRES)	304	Annealed	Low-pressure applications such as fuel lines. Unsatisfactory for high-pressure hydraulic lines. Has high degree of resistance to corrosion.
MIL-T-8504 18-8 CRES	304	Annealed	Unsatisfactory for use in applications assembled by welding or brazing, or exposure to temperatures higher than 800° F due to impaired resistance to corrosion. Used in high-pressure hydraulic/pneumatic systems.
MIL-T-8606 18-8(Stabilized and Low Carbon) CRES	304L (low carbon) 321 (stabilized) 347 (stabilized)	Annealed	Hydraulic/mechanical systems in tank/automotive applications. Has high resistance to corrosion and to temperatures up to 1500°F. Suitable for applications requiring welding/brazing. When systems are to be assembled with welded joints between tubes and fittings, MIL-T-8808 is recommended.
AMS 5569	304L (low carbon)	1/8 H	Used in high-pressure hydraulic/ pneumatic systems assembled with brazed sleeve joints. Suitable for use in moderately corrosive or oxidizing environments, temperatures to 1200° F. Weldable. For reasons of economy, tubing for use with welded fittings and tubing less than ¼ inch OD should be processed to MIL-T-8808.
AMS 5584	316L (low carbon)	1/8 H	
AMS 5896	321 stabilized	1/8 H	
AMS 5897	347 stabilized	1/8 H	

Table 1. Corrosion Resistant Steel Tubing (Continued)

Specification Tubing Material	Type	Condition	General Usage and Applications
AMS-T-6845 18-8 CRES	304	1/8 H	Used in high-pressure hydraulic/ pneumatic systems. Available only in ¼ inch OD and larger. Unsuitable for welding/brazing applications or exposure to temperatures above 800° F due to impaired resistance to corrosion.
MIL-T-5695 18-8 CRES	304	1/4 H 1/2 H	Used for aircraft structural parts or similar applications not requiring sharp bends or flaring. Unsatisfactory for welding other than resistance weld.
MIL-T-8808 18-8 (stabilized) CRES	321 347	Annealed	Aircraft hydraulic quality, used in high-pressure hydraulic/pneumatic systems. Most often used in these systems requiring brazing/welding.
AMS 5561 21-6-9 CRES	21-6-9	Cold Worked	High pressure hydraulic/pneumatic tubing requiring corrosion resistance. Tubing has good oxidation resistance up to 1100°F. Weldable.
AMS 5565 CRES	304	Annealed	Similar to AMS-T-8506
AMS 5567	304	Annealed	Similar to AMS-T-8504

Table 2. Aluminum Alloy Tubing Applications

Old Specification	New Specification	Type	General Usage and Applications
WW-T-383	WW-T-700/1	1100 - 0 - H12 - H14 - H16 - H18	CAUTION Tubing conforming to Federal Specification WW-T-700/1 shall not be used in hydraulic systems.
			Specification covers tempers from annealed to full-hard. Used mostly in O-annealed condition. Good formability. Used where high strength is not necessary, as low- or negative-pressure (nonhydraulic) lines.
WW-T-787	WW-T-700/4	5052 - 0 -H32 -H34 -H36 -H38	Specification covers tempers from annealed to full-hard. Used mostly in O-annealed condition. Has good workability. Used in medium-pressure systems (1500 psi max.).

Table 2. Aluminum Alloy Tubing Applications (Continued)

Old Specification	New Specification	Type	General Usage and Applications
WW-T-789	WW-T-700/6	6061 - 0 - T4 - T6 (Note 1)	Specification covers annealed and three heat-treated tempers. Used mostly in O-annealed and T-6. Has good workability.
	AMS-T-7081 6061 Al	T4 T6	Specification covers annealed and three heat treated tempers used mostly in O-annealed and T-6. Has good workability. The 6061-T6 is used in hydraulic / pneumatic 3000 psi systems.
	AMS 4083	6061-T6	This tubing has been used typically for parts operating under high pressure, such as hydraulic systems and fuel and oil lines, but usage is not limited to such applications.
Notes: 1. Only 6061-T6 is of sufficient strength to use in the repair of aluminum tubing systems. In an emergency, the other alloys of aluminum may be used with AN fittings to make temporary repairs only.			

Table 3. Titanium Alloy Tubing Applications

Specification	Type	General Usage and Application
AMS 4945 (3Al-2.5V)	105 CWSR	Specification covers 3Al-2.5V seamless, controlled contractile strain ratio, cold worked stress relieved hydraulic tubing.
MMS 1205 (3Al-2.5V)	95 CWSR	

Table 4. Authorized Tubing Material Substitutes

Original Tubing Material	Repair of Assemblies	Replacement of Assemblies
AMS 5561 (21-6-9 CRES) Stainless Steel (Note 8)	AMS-T-6845 (304-1/8H) (Notes 1 and 2)	AMS-T-6845 (304-1/8H) TYP-0 (Note 7)
U. K. DTD-5016 Annealed Stainless Steel	MIL-T-8808 (321) (Note 1) MIL-T-8606 (321) (Note 1)	MIL-T-8808 (321) MIL-T-8606 (321)
Other Stainless Steel (nonwelded)	AMS-T-6845 (304-1/8H) (Notes 1 and 2)	AMS-T-6845 (304-1/8H)
Other Stainless Steel (welded/brazed)	AMS-T-6845 (304-1/8H) (Notes 1 and 2) MIL-T-8808 (321) (Note 3)	MIL-T-8808 (321) (Note 5) AMS-T-6845 (304-1/8H)
Titanium (3 Al-2.5V) (Note 8)	AMS-T-6845 (304-1/8H) (Note 2 & 10)	AMS-T-6845 (304-1/8H) Titanium (3 Al-2.5V)
Aluminum (Note 4)	SAE AMS 7081 (6061-T6) (Notes 1 and 2) AMS-T-6845 (304-1/8H)	AMS-T-6845 (304-1/8H) (Note 6) SAE AMS 7081 (6061-T6)

Notes:
1. Temporary repair: Repair section spliced into line with approved MS/AN fittings.
2. Permanent repair: Repair section spliced into line with Permaswage 21-6-9 fittings.
3. Permanent repair: Repair section spliced into line by welding or brazing; this form of repair authorized at Depot level only.
4. Permaswage equipment shall not be used to repair or fabricate tube assemblies of aluminum other than aluminum alloy 6061-T6. Tube assemblies of aluminum alloy per SAE AMS 7081 D3 (6061-T6) may be permanently repaired with Permaswage fittings. Use of alloys other than 6061-T6 constitutes a temporary repair only.
5. Brazed or welded - authorized at Depot level only.
6. Authorized replacement on attrition basis for aluminum tube assembly having failure history or when determined that failure was due to fatigue. These aluminum connecting fittings must be replaced with approved CRES fittings when tubing 304-1/8H is used to replace aluminum alloy tubing. Aluminum 6061-T6 and CRES 304-1/8H tubing may be spliced together with Permaswage CRES fittings.
7. Tubing AMS-T-6845, with Permaswage separable fittings installed in accordance with the provisions of this manual, is authorized replacement for brazed installations of stainless steel 21-6-9.
8. Use of flareless sleeves MS21922 or flared sleeves MS20819 on CRES 21-6-9 or titanium tubing 3 AL 2.5V is prohibited. Field/depot repair of CRES 21-6-9 tubing may only be accomplished by methods described in this manual. Do not substitute MS21922 carbon steel flareless sleeves with MS21922-C corrosion resistant steel sleeves.
9. Use WP002 00, Table 2 for identifying tube fitting color and material code.
10. May require increased wall thickness tubing. Contact cognizant engineering authority.

Table 5: Standard Dimensions for AND10102 Round, Seamless, Steel Tubing

Tubing Outside Diameter	Nominal Wall Thickness																					
	.022	.028	.035	.042	.049	.058	.065	.072	.083	.095	.109	.120	.134	.156	.188	.219	.250					
3/16	X	X	X		X																	
1/4	X	X	X	X	X	X	X															
5/16	X	X	X		X	X	X		X	X												
3/8	X	X	X	X	X	X	X		X	X		X										
7/16		X	X	X	X	X	X	X	X	X		X										
1/2		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
9/16		X	X	X	X	X	X		X	X	X	X		X	X	X						
5/8		X	X	X	X	X	X	X	X	X	X	X	X	X	X							
11/16			X		X				X	X	X	X			X	X	X					
3/4		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X					
13/16		X				X	X		X	X		X			X							
7/8		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X					
15/16							X		X			X	X	X								
1			X		X	X	X		X	X		X			X	X	X					
1-1/16					X		X			X	X	X										
1-1/8		X	X		X	X	X	X	X	X		X			X	X	X					
1-3/16		X			X		X		X	X	X	X										
1-1/4			X		X	X	X			X	X	X	X	X	X	X	X					
1-5/16							X					X		X	X	X						
1-3/8			X		X	X	X		X	X		X		X	X	X	X					
1-7/16					X					X				X								
1-1/2			X	X	X	X	X	X	X	X		X		X	X	X	X					
1-9/16							X		X	X				X	X							
1-5/8			X		X	X	X		X	X		X		X	X	X	X					
1-3/4			X		X	X	X			X	X	X		X	X	X	X					
1-7/8					X	X	X		X	X	X	X		X	X	X	X					
2			X		X	X	X	X	X	X	X	X	X	X	X	X	X					

Table 5: Standard Dimensions for AND10102 Round, Seamless, Steel Tubing (Cont.)

Tubing Outside Diameter	Nominal Wall Thickness																
	.022	.028	.035	.042	.049	.058	.065	.072	.083	.095	.109	.120	.134	.156	.188	.219	.250
2-1/8					X	X	X		X	X		X		X	X	X	X
2-1/4					X	X	X		X	X	X	X		X	X		X
2-3/8						X	X		X	X		X		X	X		
2-1/2					X	X	X		X	X		X		X	X	X	X
2-3/4						X	X		X	X	X	X		X	X		X
3						X	X		X	X	X	X		X	X	X	X
3-1/4										X						X	X
3-1/2										X		X				X	
Material:																	
Steel																	

Table 6: Standard Sizes for AND10104 Round, Seamless, Corrosion-Resistant, Steel Tubing

Tubing Outside Diameter	Nominal Wall Thickness																								
	.012	.016	.020	.025	.028	.035	.042	.049	.058	.065	.078	.083	.095	.109	.120	.134	.156	.185	.188	.219	.250
1/8	X		X		X	X															
3/16		X	X		X	X		X													
1/4	X	X	X		X	X		X													
5/16	X	X	X		X	X	X	X	X	X											
3/8			X		X	X		X	X	X	X	X									
7/16			X		X	X		X	X			X									
1/2			X		X	X	X	X	X	X		X	X		X						
9/16						X								X							
5/8			X		X	X	X	X	X	X		X	X		X						
11/16										X											
3/4			X		X	X	X	X	X	X		X			X						
7/8						X			X			X	X								
1			X		X	X		X	X	X		X			X						
1-1/8						X		X		X		X			X			X			
1-1/4				X	X	X		X		X		X			X						
1-3/8						X		X	X			X									
1-1/2			X	X		X	X	X	X	X			X								
1-5/8						X		X	X												
1-3/4						X		X					X								
1-7/8							X														
2						X		X		X			X						X		
2-1/4						X		X		X		X			X						X
2-3/4						X		X		X					X					X	
3						X		X		X			X							X	

Table 6: Standard Sizes for AND10104 Round, Seamless, Corrosion-Resistant, Steel Tubing (Cont)

Tubing Outside Diameter	Nominal Wall Thickness																			
	.012	.016	.020	.025	.028	.035	.042	.049	.058	.065	.078	.083	.095	.109	.120	.134	.156	.185	.188	.219	.250
3-1/4								X							X					X	
3-1/2								X					X								
MATERIAL:																					
STEEL MILITARY SPECIFICATION MIL-T-5695, MIL-T-6845, MIL-T-8504, MIL-T-8506, OR MIL-T-8606.																					

table 7: Standard Sizes for AND10106 5052 Aluminum Alloy, Round Tubing

Tubing Outside Diameter	Nominal Wall Thickness					
	.028	.035	.042	.049	.058	.065
1/8	X	XO				
3/16	X	XO				
1/4	-X	XO				
5/16		XOA	X			
3/8	-X	XOB	X	XO		
1/2	-X	XOC	X	XO	X	X
5/8		XO	X	XO		
3/4	X	-XO		XO		
1	X	-XO		XO		XO
1-1/4		-XO		XO		
1-1/2	X			-XO		X
1-3/4				-XO		
2		X		-XO		X
2-1/2		X				X
3				X		X

Code:
X indicates size standards for use in current aircraft production and for new design.
O indicates warehouse stock sizes.
- indicates standard sizes for electrical conduit.
A indicates low pressure oxygen size.
B indicates liquid oxygen filler line size.
C indicates liquid oxygen build up and vent line size.
Material:
Aluminum alloy, Federal Specification WW-T-700/4.

Table 8: Standard Sizes for AND10107 2024 Aluminum Alloy, Round Tubing

Tubing Outside Diameter	Nominal Wall Thickness															
	.022	.028	.035	.042	.049	.058	.065	.083	.095	.109	.120	.134	.156	.188	.219	.250
3/16	X		X	X	X											
1/4		X	X		X	X										
5/16		X	X		X	X	X	X	X							
3/8		X	X	X	X	X	X	X	X	X						
7/16	X	X	X		X	X	X	X	X		X					
1/2		X	X		X	X	X	X	X	X	X					
9/16							X	X	X		X					
5/8	X	X	X		X	X	X	X	X							
11/16								X								
3/4		X	X	X	X	X	X	X			X					
7/8			X		X	X	X		X		X					
1			X		X	X	X	X	X							
1-1/8			X		X	X	X	X		X	X					
1-1/4			X		X	X	X	X			X		X			
1-3/8					X	X	X	X								
1-1/2			X		X	X	X	X	X		X					X
1-5/8					X		X	X						X		
1-3/4			X		X	X	X	X	X		X		X			X
1-7/8						X								X		X
2			X		X	X	X	X	X		X		X	X		X
2-1/4						X	X	X			X					
2-1/2							X		X		X		X			X
2-3/4						X		X	X							
3							X	X	X		X		X			X
3-1/2							X		X	X						
4									X	X			X	X		

Material:
Aluminum alloy 2024, Federal Specification WW-T-700/3

Table 9: Standard Sizes for AND10108 Aluminum Alloy, Round Tubing

Tubing Outside Diameter	Nominal Wall Thickness																							
	.022	.028	.035	.042	.049	.058	.065	.083	.095	.109	.120	.134	.156	.188	.203	.219	.250	.375
3/16																		
1/4																		
5/16																		
3/8																		
7/16																		
1/2																		
9/16																		
5/8																		
11/16																		
3/4			X															
7/8					X	X	X											
1				O	X		X				X							
1-1/8						X	X											
1-1/4				X												X		
1-3/8			X															
1-1/2																		
1-5/8																		
1-3/4					X											X		
1-7/8					X											X		X
2	X		X															
2-1/4																		
2-1/2						O										X		X
2-3/4						O										X		X
3							X		X							X		X

Table 9: Standard Sizes for AND10108 Aluminum Alloy, Round Tubing (Cont)

Tubing Outside Diameter	Nominal Wall Thickness																	
	.022	.028	.035	.042	.049	.058	.065	.083	.095	.109	.120	.134	.156	.188	.203	.219	.250	.375
3-1/2																		
4																		

Code:
X indicates standard sizes of heat-treated tubing 6061T.
O indicates standard sizes of annealed tubing 60610.
Material:
Aluminum alloy 6061, Federal Specification WW-T-700/6.

Table 10: Standard Sizes for 1100 Aluminum Alloy, Round Tubing

Tubing Outside Diameter	Nominal Wall Thickness					
	.022	.028	.035	.042	.049	.065
3/16	X					
1/4	X		O		O	
3/8	X	O	O		O	
1/2		X	O		O	
5/8		X	O	O	O	
3/4			X	O	O	
1			X		O	O
1-1/4			X	O	O	
1-1/2			X	O	O	
1-3/4			X	O	O	
2			O		X	O

Code:
O indicates standard sizes, general purpose.
X indicates standard sizes for electrical conduit.
Material:
Aluminum 1100-1/2 H, Federal Specification WW-T-700/1.

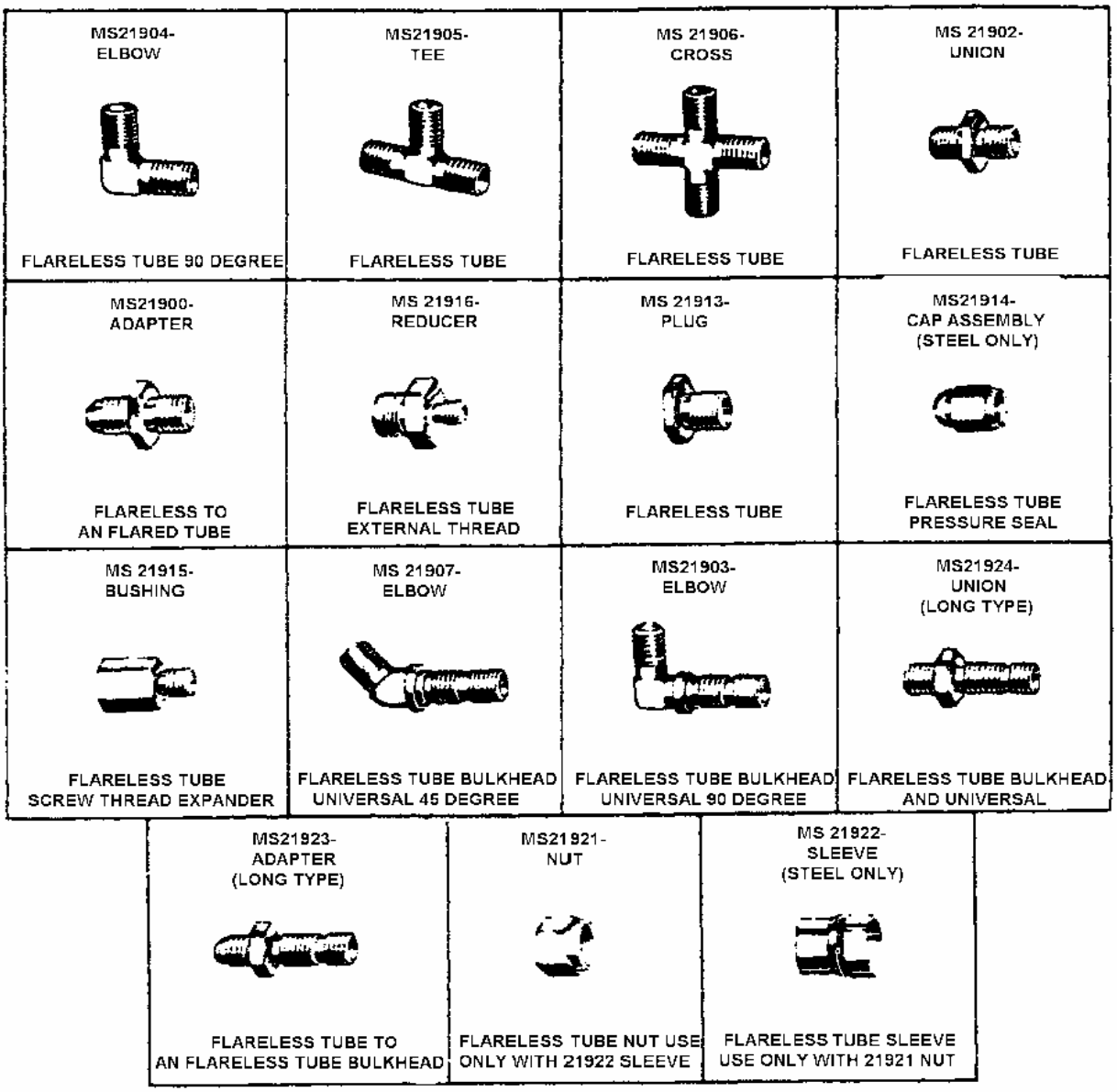
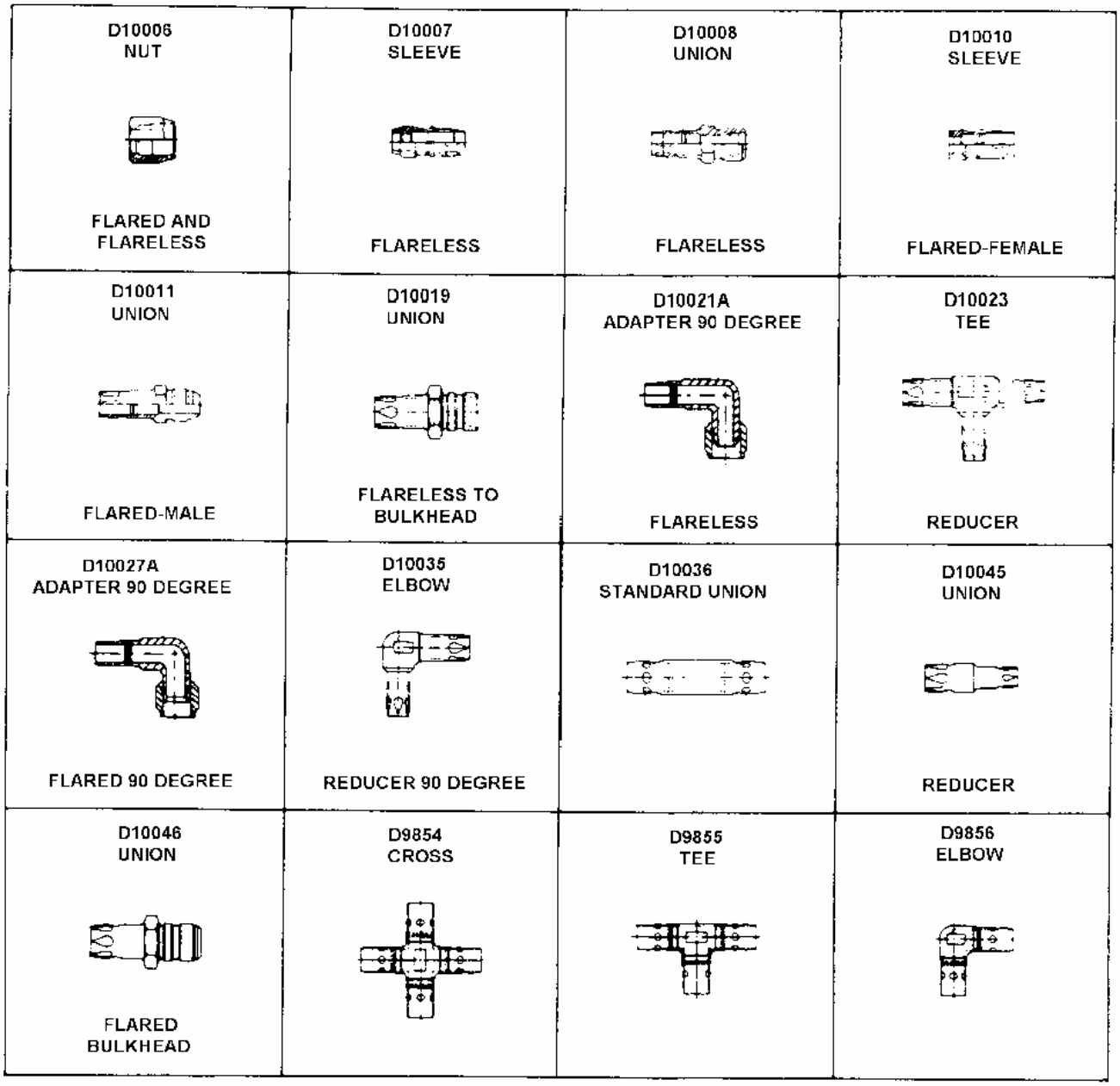


Figure 1. Typical Styles and Part Number Breakdown of MS Fittings

AN 832 UNION  FLARED TUBE BULKHEAD AND UNIVERSAL	AN 833 ELBOW  FLARED TUBE BULKHEAD UNIVERSAL 90 DEGREE	AN 834 TEE  FLARED TUBE BULKHEAD AND UNIVERSAL	AN 837 ELBOW  FLARED TUBE AND UNIVERSAL 45 DEGREE
AN 6289 NUT  FLARED TUBE UNIVERSAL FITTING	MS20825 TEE  FLARED TUBE PIPE THREAD ON SIDE	MS20826 TEE  FLARED TUBE PIPE THREAD ON RUN	AN 827 CROSS  FLARED TUBE
AN 824 TEE  FLARED TUBE	AN 821 ELBOW  FLARED TUBE 90 DEGREE	MS20822 ELBOW  FLARED TUBE AND PIPE THREAD 90 DEGREE	AN 815 UNION  FLARED TUBE
AN894 BUSHING  SCREW THREAD EXPANDER	AN 775 BOLT  UNIVERSAL FITTING	AN 776 ELBOW  UNIVERSAL 90 DEGREE	AN 929 CAP  PRESSURE SEAL FLARED TUBE FITTING
AN 806 PLUG  FLARED TUBE	AN 938 TEE  INTERNAL SCREW THREAD	AN 939 ELBOW  INTERNAL SCREW THREAD 90 DEGREE	AN941 ELBOW  INTERNAL SCREW THREAD 45 DEGREE

008002

Figure 2. Typical Styles of AN Fittings

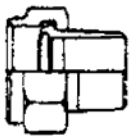
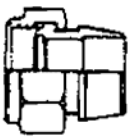
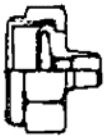
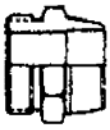
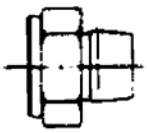
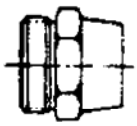
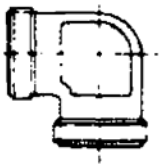
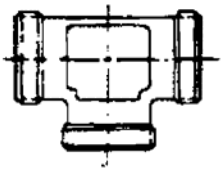
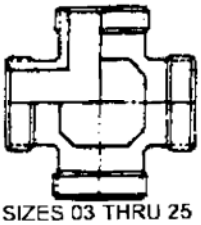
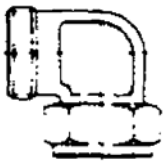
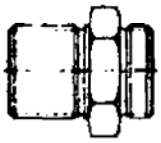


EXAMPLE OF CODE: D10006 - 6

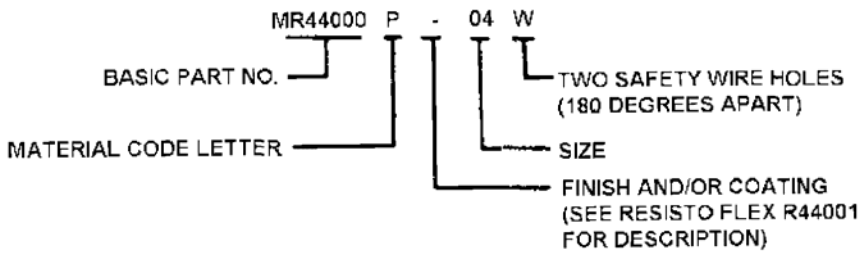
- TUBE SIZE (3/8 INCH OD)
- MATERIAL (CORROSION RESISTANT STEEL)
- BASIC PART NO.

008003

Figure 3. Typical Styles and Part Number Breakdown of Permaswage Fittings

MR44000 SWAGED TUBE SHOULDER  SIZES 03 THRU 12 STEEL	MR44000 SWAGED TUBE SHOULDER  SIZES 16 AND UP STEEL	MR44027 SWAGED TUBE SHOULDER  REDUCER STEEL	MR44100 SWAGED TUBE CONNECTOR  SIZES 03 THRU 24 STEEL
MR54040 SWAGED TUBE SHOULDER  SIZES 03 THRU 25 TITANIUM	R44117 CAP  SIZES 03 THRU 25 TITANIUM OR STEEL	M454027 SWAGED TUBE SHOULDER  REDUCER TITANIUM	MR54100 SWAGED TUBE CONNECTOR  SIZES 03 THRU 25 TITANIUM
R44104 45 DEGREE ELBOW  SIZES 03 THRU 25 TITANIUM OR STEEL	R44106 90 DEGREE ELBOW  SIZES 03 THRU 25 TITANIUM OR STEEL	R44111 TEE  SIZES 03 THRU 25 TITANIUM OR STEEL	R44114 CROSS  SIZES 03 THRU 25 TITANIUM OR STEEL
R44129-45 45 DEGREE ELBOW  SIZES 03 THRU 25 TITANIUM OR STEEL	R44129-90 90 DEGREE BELOW  SIZES 03 THRU 25 TITANIUM OR STEEL	R44358 BULKHEAD CONNECTOR  SIZES 03 THRU 25 TITANIUM OR STEEL	R44118 JAM NUT  SIZES 03 THRU 25 TITANIUM OR STEEL

EXAMPLE OF CODE



008004

Figure 4. Typical Styles and Part Number Breakdown of Dynatube Fittings

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

FABRICATION

TUBE ASSEMBLIES

Reference Material

Fuel and Hydraulic System Protective Closures, Description WP007 00
Permaswage Fittings, Description and Maintenance WP011 00
Aircraft Weapons Systems Cleaning and Corrosion Control, Organizational and Intermediate ..... NAVAIR 01-1A-509 Series
Anodic Coatings for Aluminum and Aluminum Alloys MIL-A-8625
Aviation Crew Systems Oxygen Equipment ..... NAVAIR 13-1-6.4
Chemical Conversion Coatings on Aluminum and Aluminum Alloys MIL-C-5541
Coating, Permanent Resin, Process for Application to Aircraft Parts MIL-C-5056
Finishes, Coatings and Sealants, Protection of Aerospace Weapons Systems MIL-STD-7179
Nut, Sleeve Coupling, Flareless FSC 4730 ..... SAE AS 21921
Resin Coating, Permanent for Engine Compartments and Metal Parts MIL-PRF-3043
Sleeve, Coupling, Flareless FSC 4730 ..... SAE AS 21922
Tube Bend Radii ..... SAE AS 33611
Tube, Alluminum Alloy, Drawn, Seamless, 6061 ..... WW-T-700/6
Tube, Aluminum Alloy Seamless, Round, Drawn, 6061 Aircraft Hydraulic Quality ..... SAE AMS 7081

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Record of Applicable Technical Directives

None

1. GENERAL.

2. Fabricating tube assemblies for aircraft and related equipment requires some basic skills and a few hand tools. The skills required are the ability to follow step-by-step instructions and the ability to manipulate the hand tools required.

3. GENERAL TOOLS AND EQUIPMENT. Fabricating tube assemblies is done at intermediate and depot levels. Intermediate and depot level shops are equipped with tube fabricating machinery, tools, and proof pressure testing equipment. Each machine or equipment is supplied with operating instructions.

4. SPECIAL HAND TOOLS. The following hand tools are required to fabricate tube assemblies:

Support Equipment Required

Part No. or Type Designation	Nomenclature
—	Tube Cutter
—	Deburring Tools
—	Hand Tube Bender or Mechanical Tube Bender
—	Tube Flaring Tool (Single Flare)
—	Tube Flaring Tool (Double Flare)
—	Mandrels

5. PROCEDURES.

SEE IRAC #8

Materials Required

Specification or Part Number	Nomenclature
A-A-58092	Antiseize Tape
MIL-H-81019	Hydraulic Fluid
MIL-PRF-23699	Oil, Lubricating
SAE AMS-G-4343	Grease, Pneumatic System
SAE AMS-G-6032	Grease, Plug Valve

6. Fabricating tube assemblies consists of the following basic operations:

a. Inspection

b. Tube cutting

c. Tube deburring

d. Tube bending

e. Tube joints preparation

7. INSPECTION. Inspections of bulk tubing and fittings shall be performed before and during fabrication.

8. TUBE CUTTING. When cutting tubing, the objective is to produce a square end, free from burrs. Tubing shall be cut with a standard tube cutter (Figure 1), or the Permaswage chipless cutter described in WP011 00. To cut tubing, proceed as follows:

CAUTION

Too much pressure applied to the cutting wheel at one time may deform the tubing or cause excessive burrs.

a. Place tube in cutter with cutting wheel at point where cut is to be made.

b. Apply light pressure on tube by adjusting the tightening knob.

c. Rotate cutter toward its open side (Figure 1).

d. As cutter is rotated, adjust tightening knob after each complete turn to maintain light pressure on cutting wheel.

e. **(AIR FORCE, FIELD USE ONLY)** If a cutter is not available, a hacksaw blade with 32 teeth per inch can be used.

9. TUBE DEBURRING. After tubing is cut, remove all burrs and sharp edges from inside and outside of tube (Figure 2) with deburring tools. Clean out tubing, making sure that no foreign particles remain.

NOTE

A Permaswage deburring tool may be used to remove burrs from inside of tubing (refer to WP011 00).

10. TUBE BENDING. The objective in tube bending is to obtain a smooth bend without flattening the tube. Tube bending is usually done by using a mechanical or hand-operated tube bender. In an emergency, soft, nonheat-treated aluminum tubing smaller than 1/4 inch in diameter may be bent by hand to form the desired radius. Tube Bend Data Drawing (Figure 3) may be used in the ordering and manufacturing of specific tube sections.

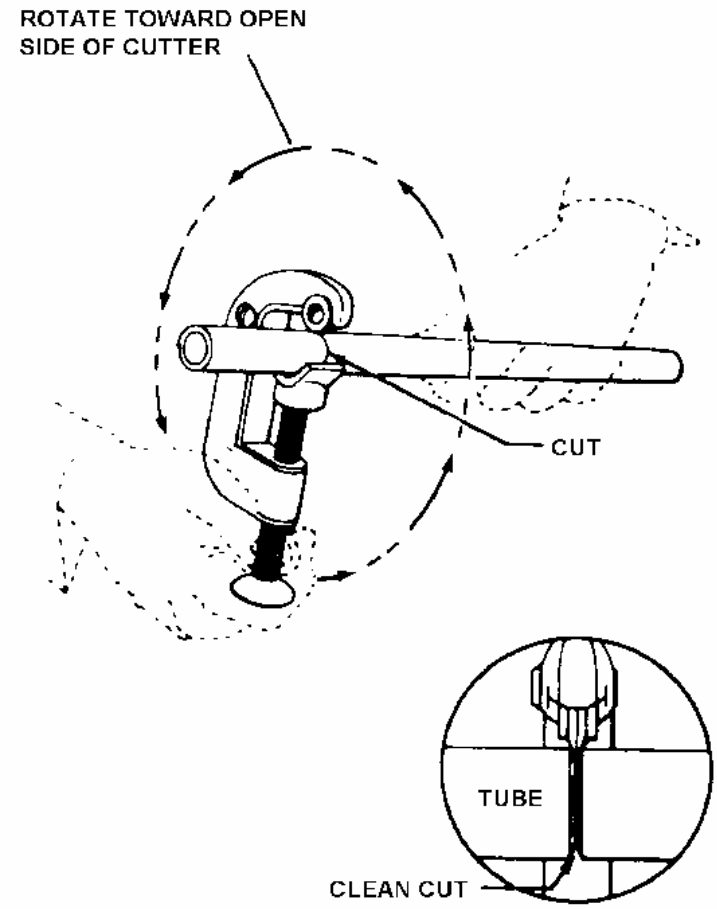

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Figure 1. Tube Cutting

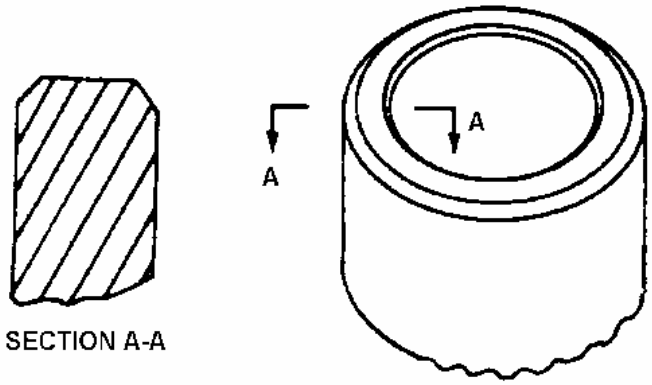

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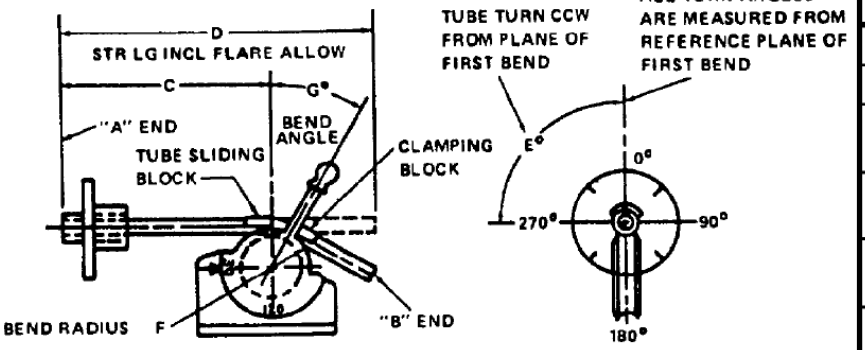
Figure 2. Properly Deburred Tubing

APPLICATION		REVISIONS			
NEXT ASSY	USED ON	LTR	DESCRIPTION	DATE	APPROVED



TUBE SIZE		
OD	WALL	D LENGTH
HEAT TREAT		
FINISH		
COLOR CODE		
PART IDENT		

BEND NO.	C DISTANCE	F BEND RADIUS	E TURN ANGLE	G BEND ANGLE

LIMIT WRINKLES FLATNESS PER MS33611

END	FITTING	TYPE
A		
B		

TYPE OF END

1	FLARE	MS33584
2	DBL FLARE	MS33583
3	BEAD	MS33660
4	SQUARE	
5	NOTED	

PROTECT ENDS PER MIL-C-5501

NOTES:
1 ADD _____ INCHES TO D LENGTH AT "A" END FOR CLAMPING, ETC. WHEN REQUIRED
2 ADD _____ INCHES TO D LENGTH AT "B" END FOR FIRST BEND WHEN REQUIRED
3 PRESSURE TEST TO _____ PSI PER _____

UNLESS OTHERWISE SPECIFIED DIM. ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS FRACTIONS ± DECIMALS XX± XXX± ANGLES ±		U.S. AIR FORCE
	DR	TITLE
	CHK	
	ENG	
	AF AUTHENTICATION	SIZE A / AF CODE IDENT NO. / DRAWING NO.
MATERIAL AND MATERIAL SPEC	AF RELEASE	SCALE / REF SPEC MIL-D-9898 / SHEET OF

F13-005

Figure 3: Tube Bend Data Drawing

a. Tube Bending With a Hand-Operated Tube Bender. The hand-operated tube bender shown in Figure 4 consists of a handle, radius block, clip and a slide bar. The handle and slide bar are used as levers to provide the mechanical advantage necessary to bend tubing. The radius block is marked on degrees of bend ranging from 0 to 180 degrees. The slide bar has a mark which is lined up with the zero mark on the radius block. The tube is inserted in the tube bender and after lining up the marks, the slide bar is moved around until the mark on the slide bar reaches the desired degree of bend on the radius block. See Figure 4 for the six procedural steps in tube bending with the hand-operated tube bender. A mandrel provides internal support to the tube during bending. In an emergency, when a mandrel is not available to provide internal support for the tube during bending, the tubing may be packed with shot or sand and both ends closed with protective closures before bending.

CAUTION

When sand or shot is used, wash or blow out all particles after tubing has been bent.

b. Tube Bending With a Mechanically Operated Tube Bender. The tube bender shown in Figure 5 is issued as a kit which contains equipment necessary for bending tube from a 1/4-inch to a 3/4-inch diameter. The mechanical tube bender is designed for use with aircraft-grade, high-strength, Corrosion-Resistant Steel (CRES) tubing as well as all other metal tubing. It is designed to be fastened to a bench or tripod, and the base is formed so as to provide a secure grip in a vise. This tube bender uses a hand crank and gears with the forming die keyed to the drive gear and secured by a screw. The forming die on the tube bender is calibrated in degrees.

11. Bend Duplication. A length of replacement tubing may be bent to duplicate a bend in the damaged tube or pattern. Duplicating the bend of the damaged tube or pattern is done by laying the pattern on top of the tube being bent and bending the new tube to the required bend.

12. Bending Requirements. Acceptable and unacceptable bends are shown in Figure 6.

NOTE

Since certain types of tubing are more elastic than others, the tubing may have to be bent beyond the required bend to allow for springback.

13. Tube Flattening. In some cases, flattening may occur when bending tubing regardless of the procedure used. As the tube flattens it assumes the shape of an ellipse in the cross section and the area is restricted. This restriction either reduces the amount of fluid actually delivered or requires additional pumping power to overcome increased line friction. Refer to Table 1 for acceptable bend flatness.

14. TUBE JOINT PREPARATION.

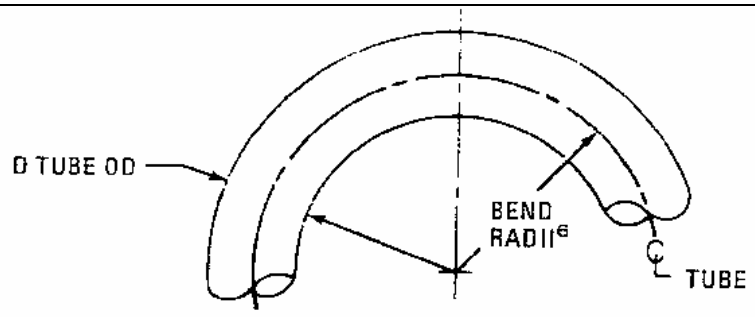
15. FLARED FITTINGS. There are three types of flared tubing joints: single-flared joint, double-flared joint, and Permaswage-flared joint (WP011 00). The single-flared tube joint is used on all sizes of steel tubing and aluminum alloy tubing 5052, conforming to Federal Specification WW-T-700/6 with 1/2 inch or larger Outside Diameter (OD). The double-flare tube joint is used on all 5052 aluminum alloy tubes with less than 1/2 OD, except when used with tube fittings NAS 590 series and connectors NAS 591 or connectors NAS 593. Both the single-flared and double-flared joints are used on aluminum alloy tubing 6061, conforming to SAE AMS 7081. Aluminum alloy tubing used in low-pressure oxygen systems or CRES used in brake systems shall be double-flared. Double-flare reduces the chance of cutting the flare by overtightening.

Acetone **14**

16. Preparing Flaring Tool For Flaring. Before flaring, the clamping surfaces of the flaring tool should be free from oil, grease, or aluminum alloy particles. The clamping surfaces may be cleaned with acetone and a stiff fiber brush. A wire brush or steel wool should not be used. The inner surface of the clamping blocks should never be sandpapered, ground, or refinished as this will render the tool unsatisfactory for use.

17. Preparing Tube Ends For Single-Flare. Use tube flaring tool (Figure 7) to prepare tube ends for flaring as follows:

Table 1. Bend Radii for Conduit and Fluid Lines



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Tube OD (Inches)	Special Bend Radii (Inches) (Note 1)		Recommended Bend Radii (Inches) (Note 2)		Additional Bend Radii (Inches) (Note 3)
	1 1/2D	2D	3D	4D	6D
1/8	.188	.250	.375	.500	.750
3/16	.281	.375	.563	.750	1.125
1/4	.375	.500	.750	1.000	1.500
5/16	.469	.625	.938	1.250	1.875
3/8	.563	.750	1.125	1.500	2.250
7/16	.656	.875	1.312	1.750	2.625
1/2	.750	1.000	1.500	2.000	3.000
5/8	.938	1.250	1.875	2.500	3.750
3/4	1.125	1.500	2.250	3.000	4.500
7/8	1.3125	1.750	2.625	3.500	5.250
1	1.500	2.000	3.000	4.000	6.000
1-1/8	1.688	2.250	3.375	4.500	6.750
1-1/4	1.875	2.500	3.750	5.000	7.500
1-3/8	2.063	2.750	4.125	5.500	8.250
1-1/2	2.250	3.000	4.500	6.000	9.000
1-5/8	2.438	3.250	4.875	6.500	9.750
1-3/4	2.625	3.500	5.250	7.000	10.500
1-7/8	2.813	3.750	5.625	7.500	11.250

Table 1. Bend Radii for Conduit and Fluid Lines (Cont)

Tube OD (Inches)	Special Bend Radii (Inches) (Note 1)		Recommended Bend Radii (Inches) (Note 2)		Additional Bend Radii (Inches) (Note 3)
	1 1/2D	2D	3D	4D	6D
2	3.000	4.000	6.000	8.000	12.000
2-1/4	3.375	4.500	6.750	9.000	13.500
2-1/2	3.750	5.000	7.500	10.000	15.000
3	4.500	6.000	9.000	12.000	18.000

Notes:
1. Use of special bends (1 1/2D to 2D) in fluid systems with working pressures of 1500 psi or greater require the approval of the procuring service. Flatness, wrinkle, and scratch requirements shall be as specified in Notes 4 and 5.
2. Recommended bends (3D and 4D) require no approval and shall be used wherever possible. Flatness, wrinkle and scratch requirements shall be as specified in Notes 4 and 5.
3. Additional bends (6D) shall be used only where fabrication or design difficulties preclude the use of recommended bends. Applications do not require specific approval and are limited only by the flatness, wrinkle and scratch requirements provided in Notes 4 and 5.
4. Flatness Limitations:
   a. Flatness in the area of a tube bend shall be defined by the formula:

$$\text{Flatness} = \frac{\text{Max OD - Min OD}}{\text{Nominal OD}} = X\ 100\%$$

   b. Tube flatness for fluid systems with working pressures of 1000 psi or greater shall not exceed 5 percent for Corrosion-Resistant Steel (CRES) and aluminum, and 3 percent for titanium.
   c. Tube flatness for fluid systems with working pressures less than 1000 psi shall not exceed 10 percent for CRES and aluminum, and 5 percent for titanium. Refer to SAE AS 33611.
5. Wrinkles and Scratches:
   a. For fluid systems with working pressures 500 psi or greater, there shall be no wrinkles or kinks deeper than 1 percent of tube Outer Diameter (OD) and no scratches deeper than 5 percent of the nominal wall thickness.
   b. For fluid systems with working pressures of less than 500 psi, there shall be no wrinkles or kinks deeper than 2 percent of tube OD and no scratches deeper than 10 percent of the nominal wall thickness.
6. Bend radii for tube diameters other than those specified may be established by multiplying the tube OD by the appropriate numerical prefix noted in the table.

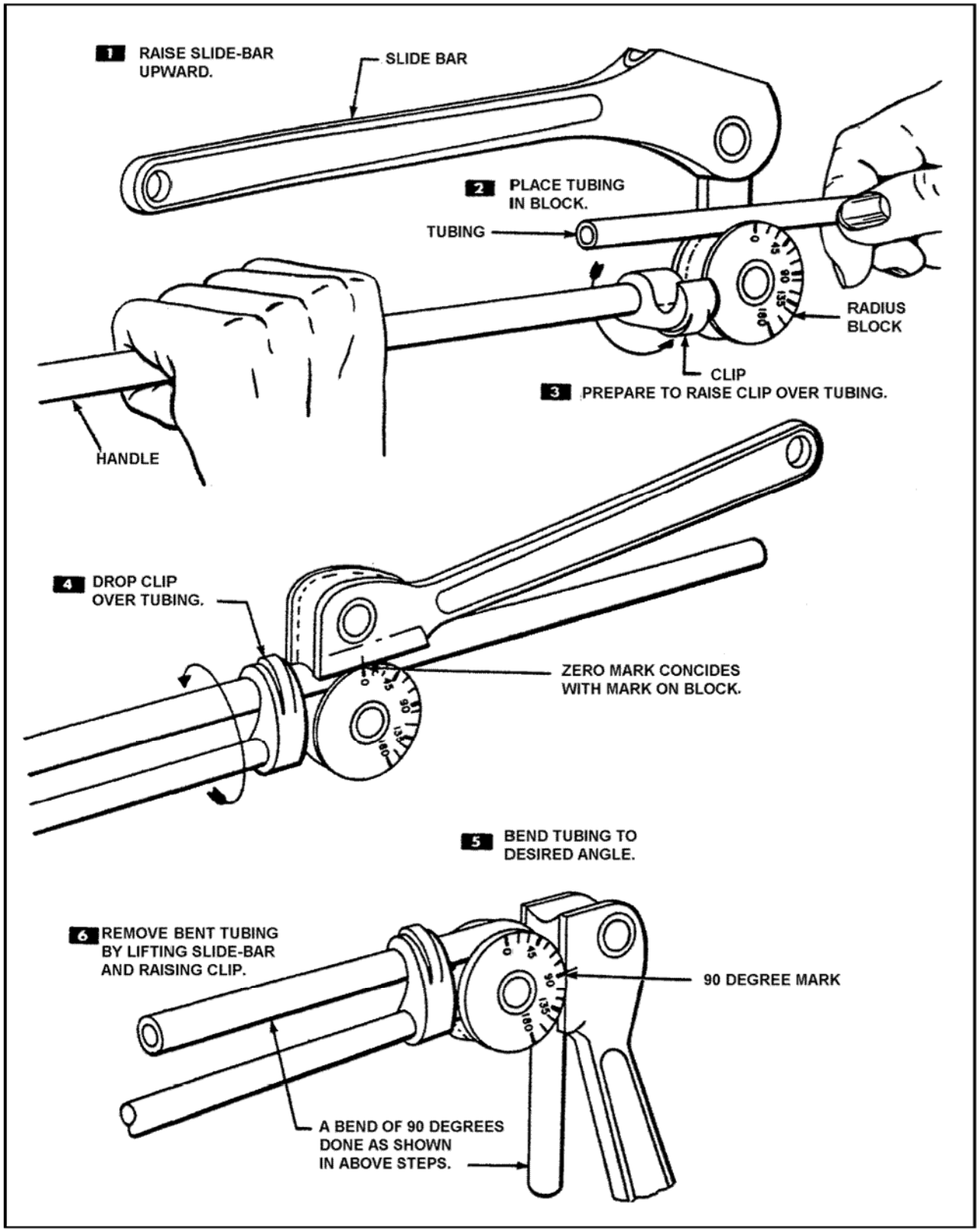

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Figure 4. Bending Tubing with Hand Operated Tube Bender

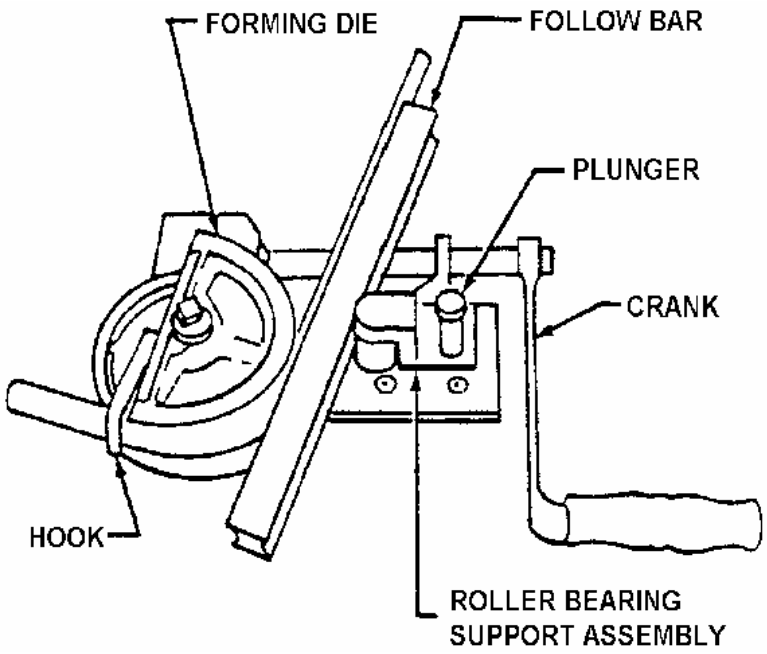

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Figure 5. Mechanically Operated Bender

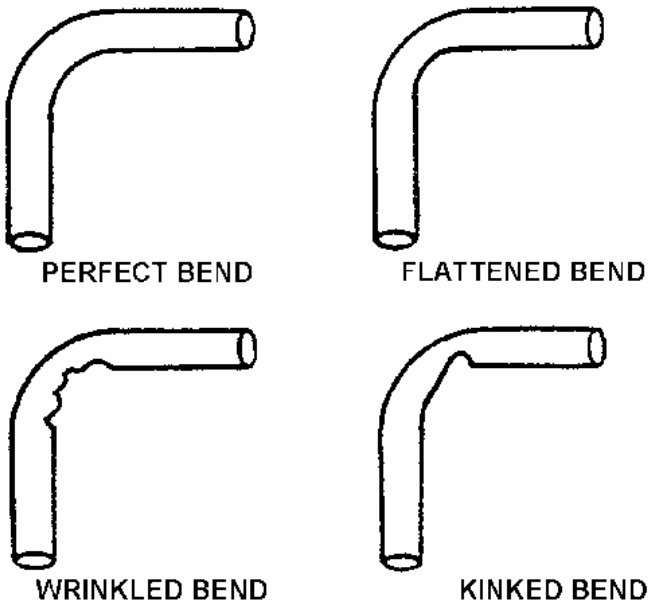

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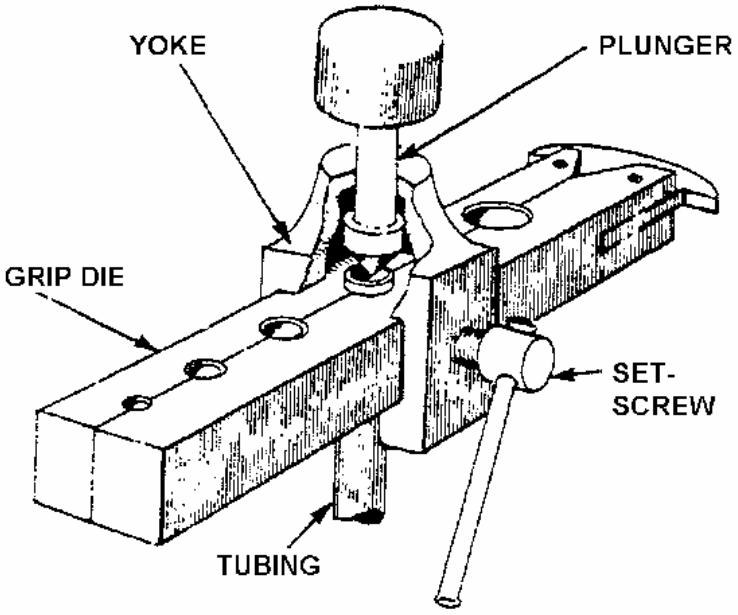
Figure 6. Tubing Bends



009006

Figure 7. Tube Flaring Tool, Single Flare

CAUTION

Drift punches, nail-set punches or any other nonconforming angular tools shall not be used for flaring.

a. Check tube ends for roundness, square cut, cleanliness, and no draw marks or scratches. Draw marks can spread and split the tube when it is flared.

b. Use a deburring tool to remove burrs from inside and outside of tubing (Figure 2).

c. Remove filings, chips, and grit from inside of tube.

d. Clean tube in accordance with Paragraph 27.

e. Slip the fitting nut and sleeve onto the tube.

f. Place the tube into proper size hole in grip die. Make sure end of tube extends 1/64 inch above surface of grip die.

g. Center plunger over end of tube and tighten yoke setscrew to secure tube in grip die and hold yoke in place.

h. Strike top of plunger several light blows with a hammer or mallet, turning plunger a half turn after each blow.

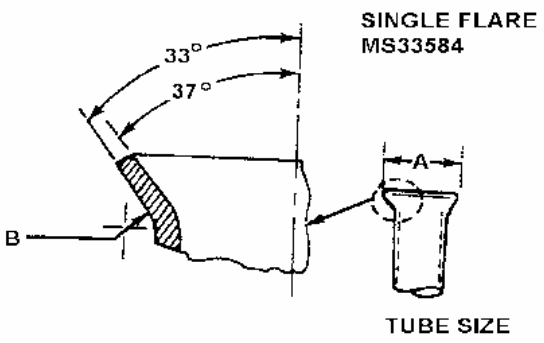
i. Loosen setscrew and remove tube from grip die.

NOTE

The OD of the single flare shall extend 1/16 inch beyond the end of the sleeve, but shall not be longer than the largest OD of the sleeve (Table 2).

j. Check to make sure that no cracks are evident and flared end of tube is no larger than the largest diameter of the sleeve being used.

Table 2. Dimensions for Single-Flare Tubing Joints



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Tube Size OD	A Diameter				B Radius ± .010
	Aluminum Alloy Tubing		Steel Tubing		
1/8	.200	+.000 -.010	.200	+.000 -.010	.032
3/16	.302	+.000 -.010	.302	+.000 -.010	.032
1/4	.359	+.000 -.010	.359	+.000 -.010	.032
5/16	.421	+.000 -.010	.421	+.000 -.010	.032
3/8	.484	+.000 -.010	.484	+.000 -.010	.046
1/2	.656	+.000 -.010	.656	+.000 -.010	.062
5/8	.781	+.000 -.010	.781	+.000 -.010	.062
3/4	.937	+.000 -.010	.937	+.000 -.010	.078
1	1.187	+.000 -.015	1.187	+.000 -.015	.093
1 1/4	1.500	+.000 -.015	1.500	+.000 -.015	.093
1 1/2	1.721	+.000 -.015	1.721	+.000 -.015	.109
1 3/4	2.106	+.000 -.015	2.106	+.000 -.015	.109
2	2.356	+.000 -.015	2.356	+.000 -.015	.109
2 1/2	2.856	+.000 -.015	2.856	+.000 -.015	.109
3	3.356	+.000 -.015	3.356	+.000 -.015	.109

18. Preparing Tube Ends For Double-Flare. (Table 3) Use tube flaring tool (Figure 8) to prepare tube ends as follows:

CAUTION

When fabricating oxygen lines, make sure all tube material and tools are kept free of oil and grease.

a. Check tube end for roundness, square cut, cleanliness and no marks or scratches. Draw marks can split the tubing when it is flared.

b. Use a deburring tool to remove burrs from the inside and outside of tube (Figure 2).

c. Remove filings, chips, and grit from inside of tube.

d. Clean tube in accordance with Paragraph 27.

e. Select proper size die blocks and place one half of the die block into flaring tool body with countersunk end towards ram guide.

f. Install nut and sleeve, lay tube in die block with 1/2 inch protruding beyond countersunk end.

g. Place other half of die block into tool body, close latch plate, and tighten clamp nuts finger tight.

h. Insert upset flare punch in tool body with gage end toward die blocks.

NOTE

The upset flare punch has one end counterbored or recessed to gage the amount of tubing needed to form a double lap flare.

i. Insert ram and tap lightly with a hammer or mallet until upset flare punch contacts die blocks and die blocks are set against stop plate on bottom of tool.

j. Use a wrench to tighten latch plate nuts alternately, beginning with closed side, to prevent distortion of tool.

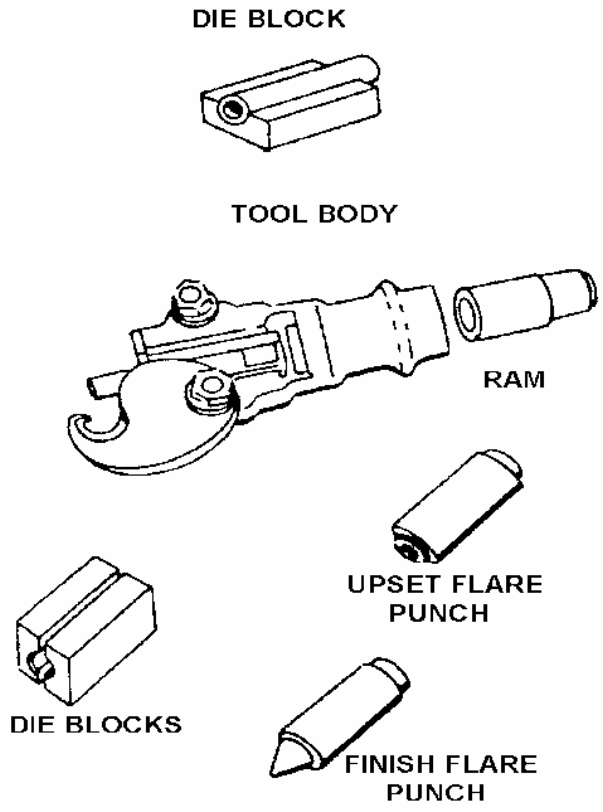


Figure 8. Tube Flaring Tool, Double Flare

k. Reverse upset flare punch; insert upset flare punch and ram into tool body. Tap lightly with a hammer or mallet until upset flare punch contacts die blocks.

l. Remove upset flare punch and ram.

m. Insert finishing flare punch and ram.

NOTE

Check the seat at intervals during the finishing operation to avoid over-seating.

n. Tap ram lightly until a good seat is formed (Figure 9). Refer to Table 3 for correct dimensions.

m. Prior to connecting a flared tubing assembly to a flared tubing fitting, the cone surface of the of the tubing assembly and the fitting should be wiped with a clean, dry cloth to remove any dust, dirt, or other foreign matter.

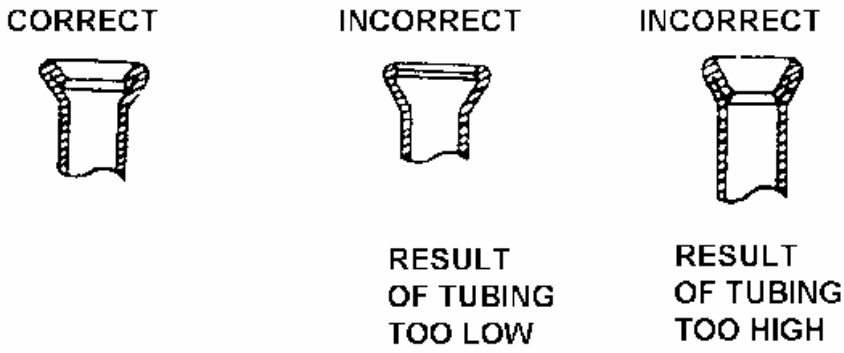


Figure 9. Tubing Position and Resulting Flare

19. Double Flare 5/16-inch Oxygen Tubing Joint. (Table 3) A hand tool is used to double flare 5/16-inch tubing used in oxygen systems. (See Figure 10) Procedures for double flaring 5/16-inch oxygen tubing are as follows:

a. Prepare tubing for flaring as outlined in paragraph 18.

b. Place sleeve and nut on tubing end.

c. Separate clamp blocks of double flare tool.

d. Place tubing double flaring tool with tubing protruding slightly above top surface of clamp blocks.

e. Close clamp blocks, slide harness into position and tighten clamp blocks by tightening screw and bar on harness.

f. Hold double flare tool in the palm of hand with tubing extending between second and third finger. (See Figure 10)

g. Insert gauging pin into pin guide hole and using a one-pound or lighter hammer tap gauging pin until shoulders of pin stop against clamp blocks. (See Figure 10, detail 1.)

h. Remove gauging pin from pin guide hole.

NOTE

If the gauging pin is not available, during an emergency the burred tubing should be placed flush with the top of the clamp blocks for an approximately correct gauging length.

i. Tighten clamp blocks securely by means of tightening screw and bar on harness. Additional leverage may be obtained by inserting one of the pins into the pin guide hole to aid in holding the tool while turning the screw.

j. Hold double flare tool in palm of hand with tubing extending between second and third fingers. (See Figure 10)

NOTE

The tightening bar should not be touched or held while the tubing is being flared.

k. Insert starting pin into pin guide hole and hammer it with sharp blows until shoulder of starting pin stops against clamp blocks.

l. Remove starting pin from pin guide hole. Do not loosen tubing.

m. Insert finishing pin into pin guide hole and hammer it with sharp blows until shoulder of finishing pin stops against clamp blocks. (See Figure 10, Detail 5)

n. Remove finishing pin and unclamp tubing.

o. Inspect finished flare for splits, cracks or defects.

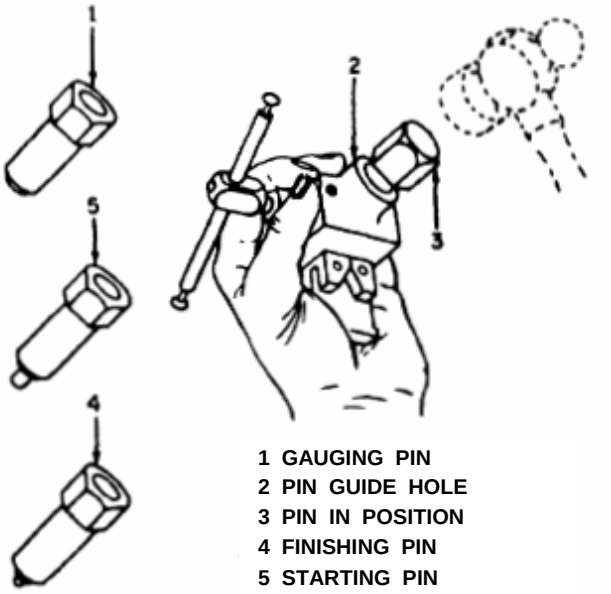


Figure 10. Double Flare Tool

20. Checking the 5/16-inch Oxygen Tubing Flare. Correct use of the double flare tool will give a perfect flare. The tool is designed for 5/16 inch tubing and automatically flares to the correct outside diameter of 0.411 to 0.421 inches. Incorrect double flares should be cut off and another flare made. (See Figure 9) A short inner flare should not be used because of the short bearing surface for the fitting nipple. The short inner flare is caused by inserting the tubing too low in the clamp blocks or by the tubing slipping during the flaring operation. Improper tightening, jamming of tightening screw, or dirt on the inner surface of the clamp blocks will cause the tubing to slip. A long inner flare should not be used because it will restrict the flow passage. The long inner flare is caused by improper gauging.

NOTE

Tubing should be flared by the single flare method only in an emergency when a double flare tool is not available.

NOTE (Air Force Only)

Depot level activities, including commercial contractors, effecting the overhaul, repair, or modification of service aircraft are prohibited from using antiseize compounds on flared tubing threads. These activities will adhere to Military Specification MIL-I-5585, and will replace fittings that are manufactured to maximum or minimum thread tolerances.

21. FLARELESS FITTINGS. Preparing tube ends for flareless fitting requires a presetting operation whereby the sleeve is set onto tubing. Tightness of nut which sets the sleeve will vary depending upon whether or not a mandrel is used during presetting (Tables 4 and 5).

22. Mandrels. A mandrel consists of a short piece of solid bar of any kind of material such as steel. The outside diameter varies from .002 to .005 inch less than the inside diameter of the tube. A mandrel is not mandatory for presetting sleeves but is recommended because it supports the inside diameter of the tube and improves sleeve cut during presetting. The length of the mandrel shall be long enough when inserted in tube to provide support to the tube at the sleeve cut and at the point where sleeve shoulder grips tube.

23. Presetting Tube Ends For Flareless Fittings. When presetting tube ends, a hand pre-setting tool (Table 6) or a standard flareless fitting body may be used. If a standard fitting body is used, do not use an aluminum fitting body more than once or a steel fitting body more than five times for presetting. Presetting procedures for flare-less fittings conforming to long sleeve AS 21922 and short nut AS 21921 (Figures 9 and 10) are as follows:

a. Select correct size presetting tool (Table 6) or a flareless fitting body.

b. Clamp presetting tool or flareless fitting body in a vise.

c. Slide a nut, and then a sleeve onto tube making sure pilot and cutting edge of sleeve points toward end of tube.

Hydraulic Fluid, MIL-H-81019 2

Grease, Plug Valve, SAE AMS-G-6032 17

Lubricating Oil, MIL-PRF-23699 **18**

Grease, Pneumatic System, SAE AMS-G-4343 **19**

d. Select lubricant from Table 7 and lubricate fitting threads, tool seat, and shoulder sleeve.

e. Place tube end firmly against bottom of presetting tool seat, while slowly screwing nut onto the tool threads with a wrench until tube cannot be rotated with thumb and fingers.

NOTE

At this point the cutting edge of sleeve is gripping tube, preventing tube rotation; fitting is ready for final tightening force needed to set sleeve on tube.

f. Tighten nut to number of turns specified in Tables 4 and 5. Sleeves removed from tube shall not be reused.

24. Check After Presetting. After presetting, unscrew nut from presetting tool or flareless fitting body and check sleeve and tube (Figure 11 and Figure 12) for the following:

a. Sleeve cutting lip shall be imbedded into tube outside diameter between .003 inch and .008 inch (1), depending on size and tubing material.

b. A lip of material will be raised under the pilot (2). The pilot of the sleeve shall contact or be quite close to outside diameter of tube (3).

c. The tube projection from sleeve pilot to tube end (4) shall be as listed in Table 8.

d. Sleeve shall be bowed slightly (6).

e. Sleeve may rotate on tube and have a maximum lengthwise movement of 1/64 inch.

f. Sealing surface of sleeve (5) which contacts the 24 degree angle of fitting body seat shall be smooth, free from scores, and shall not show lengthwise or circular cracks.

NOTE

Crazing cracks in finish are not harmful to safety or function of fitting.

g. Minimum internal tube diameter (7) shall not be less than values on Table 9.

h. Clean tubing in accordance with Paragraph 27.

i. Proof pressure test tube assembly at a pressure equal to twice intended working pressure.

25. Inspection of Tubing Flares All Diameters, Single or Double.

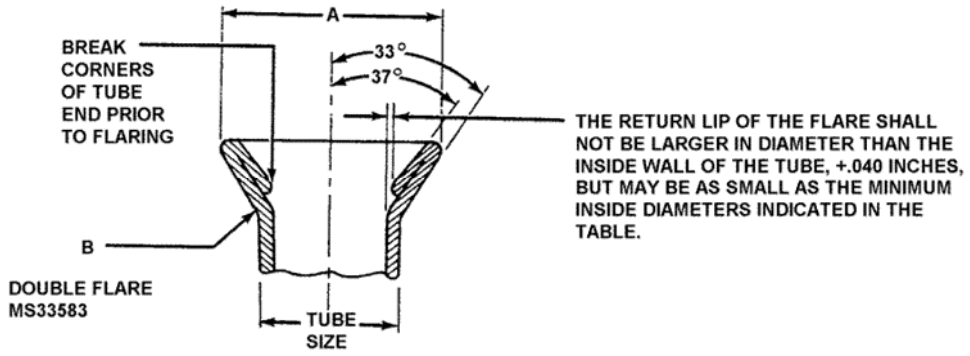
a. Use Table 2 and 3 to check for proper flare diameter using a micrometer or by using locally manufactured go-no-go gauges as detailed in Figure 13.

b. Tube flares shall be free from cracks, scratches, pits, burrs, and die marks of face of flare.

c. Tube flares shall be square with the centerline of the tube and concentric with the outside diameter of the tube within the 0.010 inch tolerance in Figure 13.

Tube flares shall show no evidence of excessive wall reduction.

Table 3. Dimensions for Double-Flare Tubing Joints



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Tube Size Nominal OD	A Diameter +.000 -.010	B Radius ±.010	Wall Thickness	Minimum ID
1/8	.200	.032		
3/16	.302	.032	.028 .035	.114 .100
1/4	.359	.032	.028 .035	.178 .159
5/16	.421	.032	.035 .049	.224 .198
3/8	.484	.046	.028 .035 .049	.310 .288 .261

Table 4. Turn Values for Presetting with Mandrels (or Solid Rod)

Tube OD[1]	All Materials Turns[1]
1/8	1
3/16	1
1/4	1
5/16	1
3/8	5/6
1/2	5/6
5/8	2/3
3/4	2/3
1	2/3
1 1/4	2/3
1 1/2	2/3
2	2/3

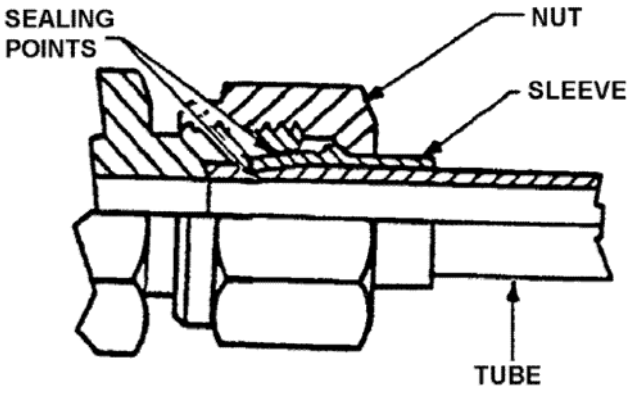

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Figure 11. Flareless Fitting Assembly

Table 5. Number of Turns for Presetting Operation Sleeve MS21922, Nut AS21921 Without Mandrels

Tube Size	Tube Material	Wall Thickness (Inches)														
		0.018	0.020	0.022	0.025	0.028	0.035	0.042	0.049	0.058	0.065	0.072	0.083	0.095	0.109	0.120
-2	AMS-T-6845 MIL-T-8504 6061-T6AL	1 1/6 1 1/6 1	1 1/6 1 1/6 1	1 1/6 1 1/6 1	1 1/6 1 1/6 1	1 1/6 1 1/6 1	 1 1/6 1									
-3	AMS-T-6845 MIL-T-8504 6061-T6AL	1 1/6 1 1/6	1 1/6 1 1/6 (Note 1)	1 1/6 1 1/6 1	1 1/6 1 1/6 1	1 1/6 1 1/6 1	1 1/6 1 1/6 1	1 1 1								
-4	AMS-T-6845 MIL-T-8504 6061-T6AL	1 1/6	1 1/6 (Note 1)	1 1/6 (Note 1) 1	1 1/6 1 1/6 1	1 1/6 1 1/6 1	1 1 1	1 1 1	1 1 1							
-5	AMS-T-6845 MIL-T-8504 6061-T6AL	1 1/6	1 1/6 1 1/6	1 1/6 1 1/6	1 1/6 (Note 1) 1 1/6	1 1/6 1 1/6 1 1/6	1 1 1/6 1 1/6	1 1 1 1/6	1 1 1	1 1 1	1 1 1					
-6	AMS-T-6845 MIL-T-8504 6061-T6AL		 1 1/6	1 1/6 1 1/6	1 1/6 1 1/6	1 1 1/6	1 1 1/6 1 1/6	1 1 1/6 1 1/6	5/6 1 1	5/6 5/6 1	5/6 5/6 1	5/6 5/6 1	5/6 5/6 1			
-8	AMS-T-6845 MIL-T-8504 6061-T6AL			 1 1/6	 1 1/6	1 1/6 1 1/6	1 1/6 1 1/6 1 1/6	1 1 1/6 1 1/6	1 1 1	5/6 5/6 1	5/6 5/6 1	5/6 5/6 1	5/6 5/6 1	5/6 5/6 1	5/6 5/6 1	5/6 5/6 1
-10	AMS-T-6845 MIL-T-8504 6061-T6AL				(Note 1) (Note 1)	1 1/6 1 1/6	1 1/6 (Note 1) 1 1/6	1 1/6 1 1/6 1 1/6	1 1 1/6 1 1/6	1 1 1 1/6	5/6 1 1	5/6 5/6 1	5/6 5/6 1	5/6 5/6 1	5/6 5/6 1	5/6 5/6 1
-12	AMS-T-6845 MIL-T-8504 6061-T6AL					(Note 1) 1	1 1/6 (Note 1) 1	1 1/6 1 1/6 1	1 1 1/6 1	5/6 1 5/6	5/6 1 5/6	2/3 5/6 5/6	2/3 5/6 5/6	2/3 5/6 5/6	2/3 5/6 5/6	2/3 5/6 5/6
-16	AMS-T-6845 MIL-T-8504 6061-T6AL						(Note 1) 1	1 1/6 (Note 1) 1	1 1/6 1 1/6 1	1 1 1/6 1	1 1 1/6 1	5/6 1 5/6	5/6 5/6 5/6	5/6 5/6 5/6	5/6 2/3 5/6	5/6 2/3 5/6
-20	AMS-T-6845 MIL-T-8504 6061-T6AL							1 1/6 1 1/6	1 1/6 1 1 1/6	1 1/6 1 1 1/6	1 1/6 1 1	5/6 1 1	2/3 1 1	3/3 1 1	2/3 2/3 1	2/3 5/6 1
-24	AMS-T-6845 MIL-T-8504 6061-T6AL							1 1/6	1 1/6 1 1/6 1 1/6	1 1/6 1 1/6 1 1/6	1 1/6 1 1 1/6	1 1 1	1 1 1	1 5/6 1	5/6 5/6 1	5/6 5/6 1
-32	AMS-T-6845 MIL-T-8504 6061-T6AL								1 1/6 1 1/6 1 1/6	1 1/6 1 1 1/6	1 1/6 1 1	5/6 1 1	5/6 5/6 1	2/3 5/6 1	2/3 5/6 1	5/6 5/6 1

Notes: 1. Because of excessive tube collapse, a mandrel should be used.

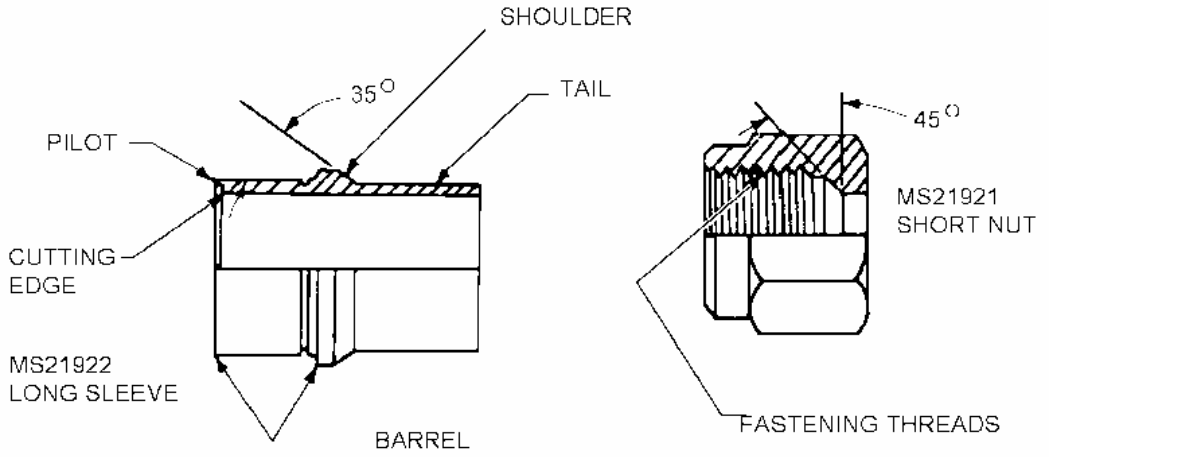


Figure 12. Long Sleeve and Short Nut

Table 6. Hand Presetting Tool

Deutsch Part No.	Dash Size	Tube OD (Note 1)
270-60002	-2	1/8
270-60003	-3	3/16
270-60004	-4	1/4
270-60005	-5	5/16
270-60006	-6	3/8
270-60008	-8	1/2
270-60010	-10	5/8
270-60012	-12	3/4
270-60016	-16	1
270-60020	-20	1 1/4
270-60024	-24	1 1/2
270-60032	-32	2
Notes: 1. All dimensions are in inches.		

Table 7. Thread Lubricants

System	Lubricant Specification
Hydraulic	MIL-H-81019
Fuel	MIL-H-81019
Oil	SAE AMS-G-6032 or MIL-PRF-23699
Pneumatic	SAE AMS-G-4343
Oxygen	A-A-58092

26. Inspection of Tubing Flares All Diameters, Short or Long. Inner flares on double flared lines are cause for rejection (see Figure 9). Incorrect double flares shall be cut off and the line RF flares (it may be necessary to fabricate a new line) short or long inner flares do not allow for proper seating and will restrict flow passage.

27. CLEANING OF FABRICATED TUBING AND TUBE ASSEMBLIES (NON-OXYGEN TUBING).

Non-Ionic Detergent, MIL-D-16791 6

28. All tubing and tube assemblies shall be cleaned after fabrication to prevent contamination of the system in which they will be installed, MIL-D-16791, Type II or III is the preferred cleaner for most tube assemblies.

29. CLEANING OF OXYGEN TUBING ASSEMBLIES

a. **(NAVY ONLY)** Clean oxygen tube assemblies using the procedures and materials described in NAVAIR 13-1-6.4-1, Chapter 4.

b. **(AIR FORCE ONLY)** Clean oxygen tube assemblies using the procedures and materials described in Work Package 009 01.

30. PROOF PRESSURE TESTING OF FABRICATED TUBING AND TUBE ASSEMBLIES.

31. Tube assemblies, fabricated according to instructions in this manual, shall be proof pressure tested to twice the operating pressure of the system in which they are to be installed, provided the operating pressure is greater than 50 psi. Tubing installed in systems having an operating pressure of less than 52 psi shall be proof pressure tested to a minimum of 100 psi. Vent tubes or drain tubes do not require proof pressure testing.

NOTE

Tube assembly repairs accomplished on board a Naval aircraft per instructions in this manual need not be removed from aircraft for proof pressure testing. Repairs can be tested by using the pressure system of the aircraft on which the repairs were made.

32. TEST MEDIA FOR NON-OXYGEN TUBING. The fluid medium for proof pressure testing of all tube assemblies except oxygen systems shall be a liquid medium such as hydraulic fluid, water, or oil.

33. TEST MEDIA FOR OXYGEN TUBING. Oxygen tubing shall be tested using dry nitrogen and inspected for leaks while the tubing is submerged in water.

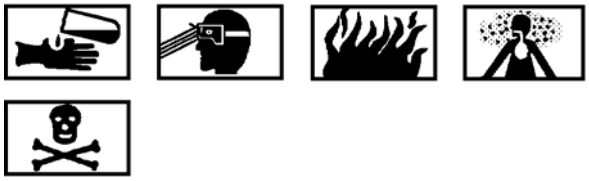
34. PROTECTIVE FINISHES.

Materials Required

Specification or Part Number	Nomenclature
MIL-PRF-23377	Epoxy Polyamide Primer
MIL-PRF-85582	Epoxy Primer
SAE AMS-S-8802	Sealant

35. Protective finishes shall be applied in accordance with MIL-STD-7179 to fabricated tube assemblies before installation or storage.

36. PROTECTIVE FINISH FOR TUBING INTERIOR AND EXTERIOR SURFACES. Interior and exterior surfaces of aluminum alloy tubing shall be surface-treated in accordance with MIL-C-5541 or MIL-A-8625, Type IC, II or IIB except oxygen lines, which shall be treated on external surfaces only. Tubing in fire extinguishing systems shall be finished internally and externally with baked resin coating conforming to MIL-PRF-3043 in accordance with MIL-C-5056.



Sealant, AMS-S-8802 11

37. PROTECTIVE PAINT FINISH FOR TUBE ASSEMBLIES. Tube assemblies that require paint as a protective finish are described in Table 10.

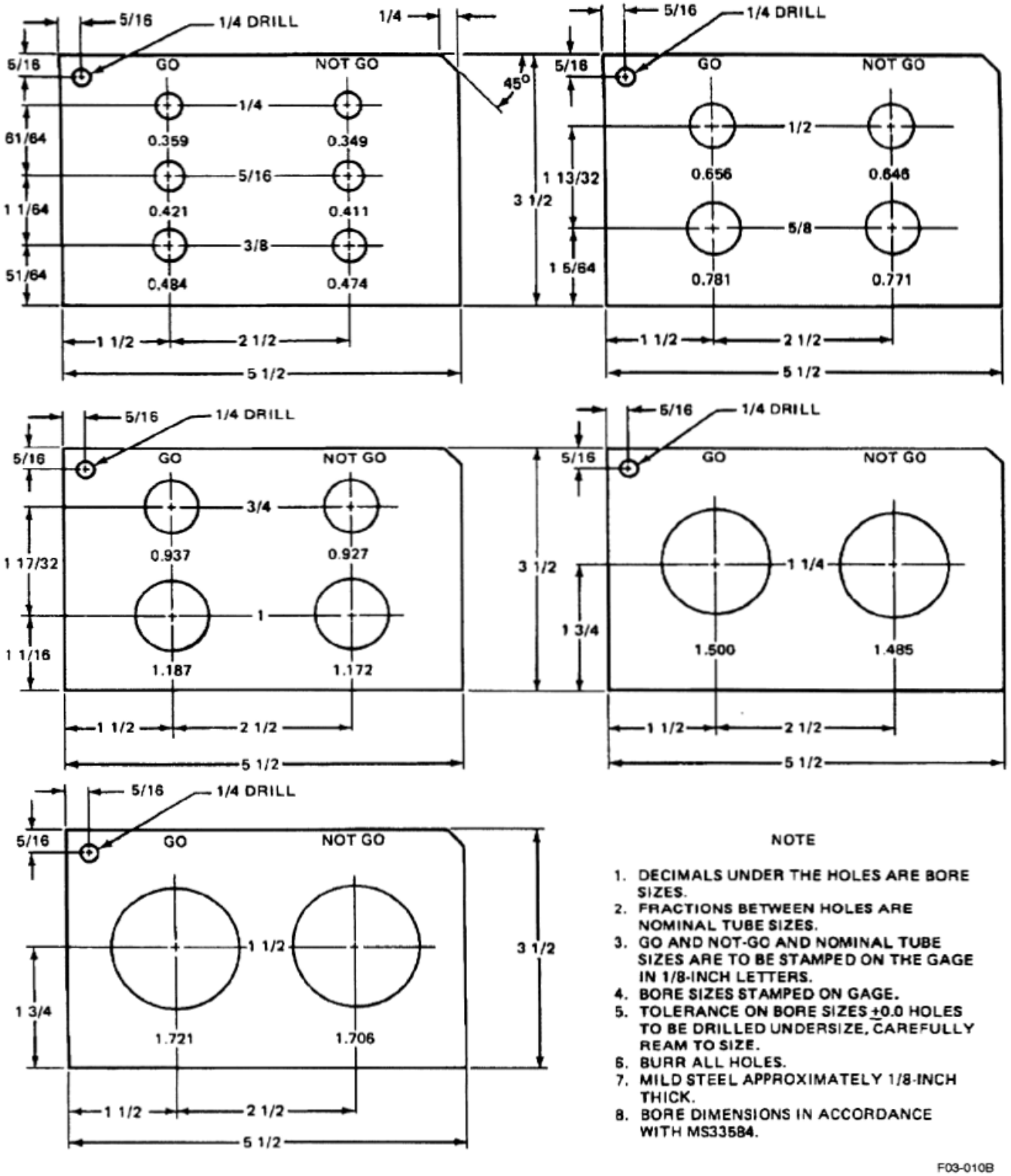


Figure 13. Go-No-Go Gauges For Tubing Flare Inspection

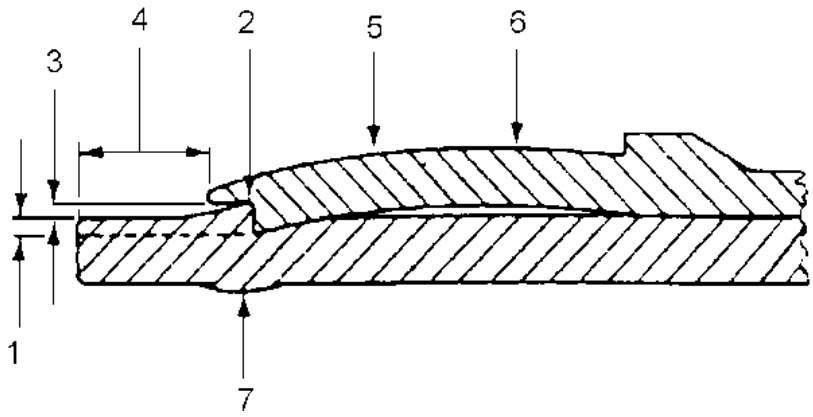


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Figure 14. Preset Sleeve

Table 8. Tube Projection from Sleeve Pilot

Tube Size	Approximate Tube Projection (Notes 1 and 2)
-2	7/64
-3	7/64
-4	7/64
-5	5/32
-6	11/64
-8	3/16
-10	13/64
-12	7/32
-16	15/64
-20	1/4
-24	1/4
-32	9/32

Notes:
1. The tube projection figures vary upon change of wall thickness for a given size. Do not use these dimensions as an inspection standard, but rather as an approximation of proper tube projection.
2. Dimensions for tube projection are in inches.

Table 9. Minimum Inside Diameter of Tubing

Tube OD (Note 1)	6061 Aluminum (Note 1)		1/8 Hard Stainless (Note 1)		Annealed Stainless (Note 1)	
	Wall	Min ID	Wall	Min ID	Wall	Min ID
1/8	.020	.060	.016	.070	.020	.060
3/16	.028	.095	.018	.110	.020	.115
1/4	.035	.150	.020	.165	.028	.155
5/16	.049	.180	.022	.225	.035	.225
3/8	.049	.240	.025	.290	.049	.270
1/2	.065	.330	.028	.400	.058	.380
5/8	.083	.420	.035	.485	.065	.475
3/4	.095	.530	.042	.610	.083	.590
1	.065	.830	.065	.840	.083	.800

Notes: 1. All dimensions are in inches.

Table 10. Prime and Paint for Tube Assemblies

Category	Description	Prime (Note 1)	Paint
I	Single tube with separate connectors at each end.	Prime after forming, but before fabrication.	Tube assemblies in categories I, II, and III shall be painted after fabrication and before installation. Except for assemblies in category III which have been partially primed. Partially primed tube assemblies in category III shall have additional primer applied as required, followed by coating of all nonsealed, nonseparable joints with SAE AMS-S-8802 before application of paint.
II	Tube assemblies consisting of individual tubes permanently joined by nonseparable fittings such as those assembled by brazing, welding, and swaging and having separable connectors at each free end.	Prime after forming, follow by coating joints with SAE AMS-S-8802 before fabrication.	
III	Single or multiple tube assemblies as in I and II, having one or more free ends which must be subsequently joined permanently to another tube assembly by brazing, welding and swaging during installation.	Prime after forming, follow by coating joints with SAE AMS-S-8802 before fabrication. CAUTION If primer is not compatible to permanent joining process, prime tubing a suitable distance away from affected end.	
IV	Other tube assemblies not described in I, II, or III.	The cognizant rework facility shall specify the required protective finishes.	

Notes: 1. Tubing assemblies in categories I, II, and III in which sleeves or ferrules are used in the separable connections and sleeves or ferrules are fixed in position by deforming one or more members, prime up to but not beyond initial point of contact. Tubing for use with flared systems shall be primed to the end of the tube.

Epoxy Polyamide Primer, MIL-PRF-23377 **9**

Epoxy Primer, MIL-PRF-85582 **10**

Do not paint interior surfaces of airspeed indicator tubing, oxygen, or other plumbing lines.

Titanium or stainless steel tubing does not require primer or paint except in area of dissimilar metals. Primer or paint on stainless steel tubing currently installed on Naval aircraft need not be removed. The basic reason for this caution is that cracked or damaged paint systems establish a differential oxygen concentration cell, which may result in tubing corrosion damage.

38. PROTECTIVE FINISH FOR INTERIOR AND EXTERIOR TUBE ASSEMBLIES. Tube assemblies located inside of an aircraft are interior tube assemblies. Tube assemblies located outside of an aircraft are exterior tube assemblies. Interior tube assemblies require a protective finish of MIL-PRF-23377 or MIL-PRF-85582 epoxy primer or equivalent, using application techniques as specified in NAVAIR 01-1A-509. Protective finishes for exterior tube assemblies shall be the same as for exterior aircraft surfaces specified in NAVAIR 01-1A-509.

39. IDENTIFICATION.

40. Fabricated tube assemblies shall be identified before installation or storage. Transfer all information from identification tag of the removed tube assembly to the tag on replacement tube assembly. Identify tube assemblies by ink stamping or stenciling part number, manufacturer's code, and other required data on tube assemblies. Apply a protective coat of clear varnish over markings.

41. IDENTIFYING TUBING SYSTEMS. To aid in rapid identification of the various tubing systems and operating pressures, code bands of varicolored tape shall be attached to the tubing near the joints and intermediate points to allow identification of the tubing system throughout the aircraft. The code identifications used are shown in Figure 15. Additional markings may be provided within the identification group to indicate subsidiary functions (example: nose gear-lower, hazards, or direction of flow). When replacing or repairing existing aircraft tube assemblies, any identification that may have been present on removed assemblies or line sections shall be transferred to the replacement assembly.

42. STORAGE.

43. Tubing and tube assemblies shall be stored as follows:

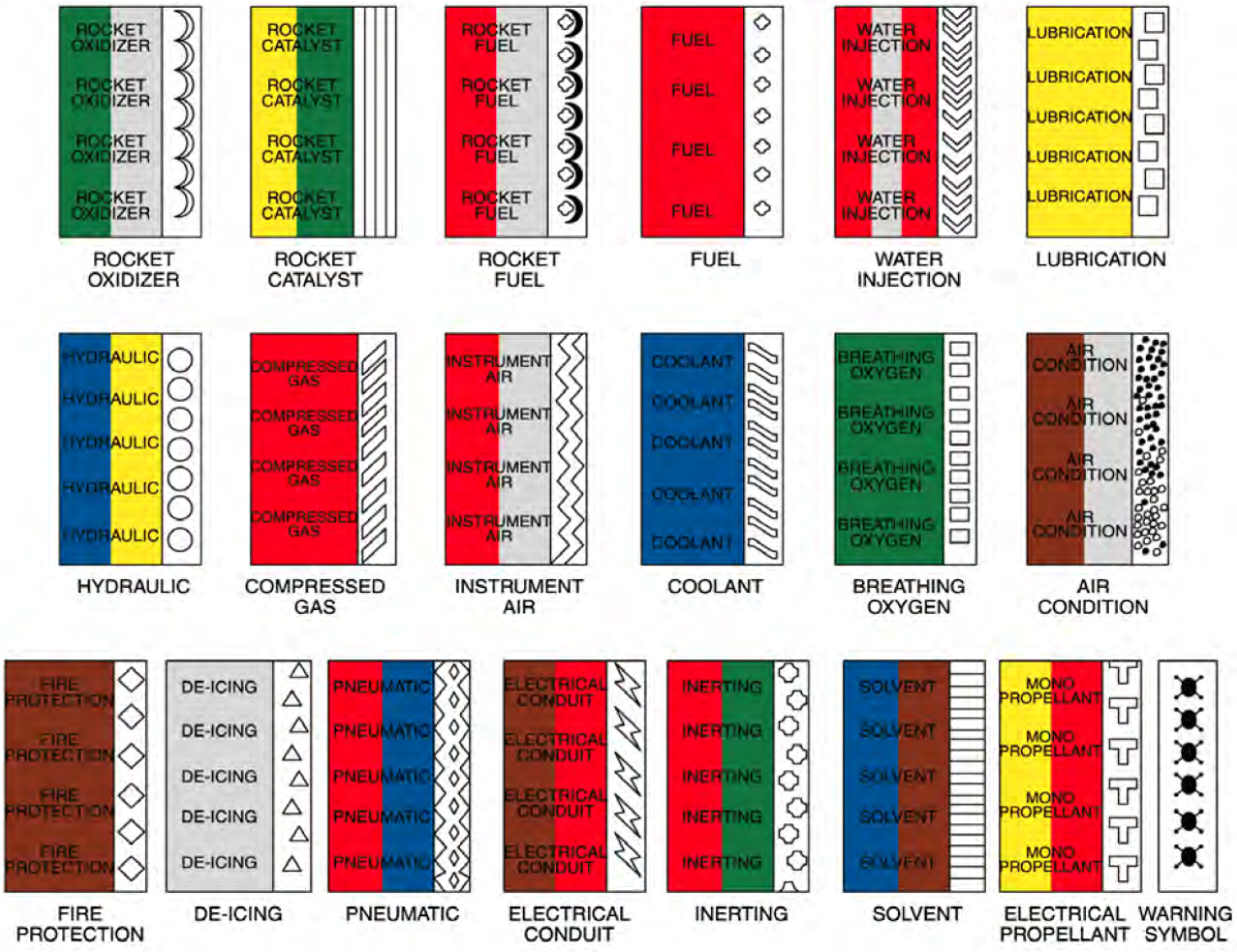
44. NON-OXYGEN TUBE ASSEMBLY STORAGE. Fabricate tubing and tube assemblies requiring storage for any length of time shall be provided with protective closures at each end (WP007 00). Do not use pressure-sensitive tape as a substitute for protective closures.

45. OXYGEN TUBE ASSEMBLY STORAGE. Oxygen tube assemblies require protection of the entire assembly in addition to protective closures at end fittings.

a. **(NAVY ONLY)** The complete assembly shall be stored and packaged in sealed plastic bags per NAVAIR 13-1-6.4-1.

b. **(AIR FORCE ONLY)** The complete assembly shall be stored and packaged according to Work Package 009 01.

Color Figures:



THE ABOVE COLOR CODES REPRESENT DESIGNATION FOR SYSTEMS ONLY. FOR CODING LINES WHICH DO NOT FALL INTO ONE OF THESE SYSTEMS THE CONTENTS SHALL BE DESIGNATED BY BLACK LETTERING ON A WHITE TAPE.

SUBSIDIARY FUNCTIONS OR IDENTIFICATION OF LINE CONTENT MAY BE INDICATED BY THE USE OF ADDITIONAL WORDS OR ABBREVIATIONS WHICH SHALL BE CARRIED ON A SECOND TAPE ADJACENT TO THE FIRST OR ALTERNATELY, INTERPOSED BETWEEN THE WORDS DESCRIPTIVE OF THE MAIN FUNCTION.

WARNING SYMBOL TAPES 3/8-INCH WIDE, SHALL BE APPLIED TO THOSE LINES WHOSE CONTENTS ARE CONSIDERED TO BE DANGEROUS TO MAINTENANCE PERSONNEL, WARNING TAPES ARE TO BE PLACED ADJACENT TO SYSTEM IDENTIFICATION TAPES.

ONE BAND SHALL BE LOCATED ON EACH TUBE SEGMENT, 24 INCHES OR SHORTER. ONE BAND SHALL BE LOCAED AT EACH END OF EACH TUBE SEGMENT LONGER THAN 24 INCHES. ADDITIONAL BANDS SHALL BE APPLIED WHEN THE TUBE SEGMENT PASSES THROUGH MORE THAN ONE COMPARTMENT OR BULKHEAD. AT LEAST ONE BAND SHALL BE VISIBLE IN EACH COMPARTMENT OR ON EACH SIDE OF BULKHEAD.

PRESSURE TRANSMITTER LINES SHALL BE IDENTIFIED BY THE SAME COLORS AS THE LINES FROM WHICH THE PRESSURE IS BEING TRANSMITTED.

FILLER LINES, VENT LINES AND DRAIN LINES OF A SYSTEM SHALL BE IDENTIFIED BY THE SAME COLORS AS THE RELATED SYSTEM.

TAPES SHALL NOT BE USED ON FLUID LINES IN THE ENGINGE COMPARTMENT WHERE THERE IS A POSSIBILITY OF THE TAPE BEING DRAWN INTO THE ENGINE INTAKE. FOR SUCH LOCATIONS, SUITABLE PAINTS, CONFORMING TO THIS COLOR CODE, AND WHICH HAVE NO DELETERIOUS EFFECT ON THE MATERIAL USED FOR THE LINES, SHALL BE USED FOR IDENTIFICATION PURPOSES. IN THESE CASES THE GEOMETRICAL SYMBOLS MAY BE OMITTED.

F13-001

Figure 15. Color-Coded Functional Identification Tapes

Black and White Figures:

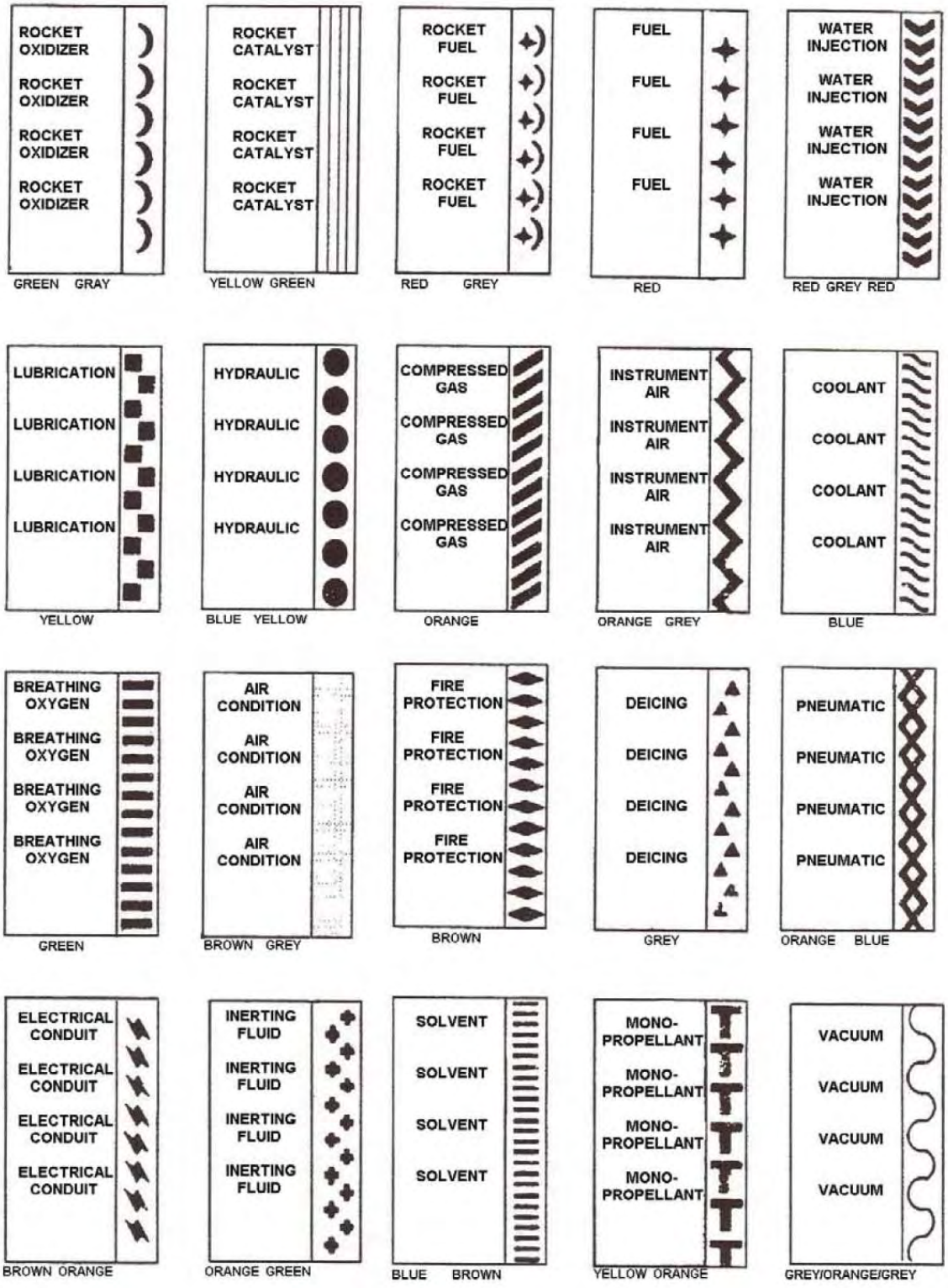
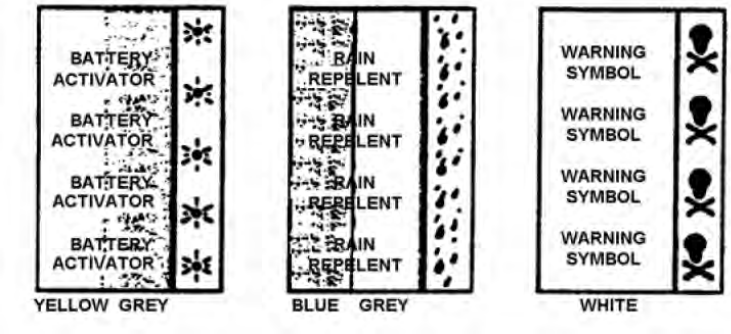


Figure 15. Color-Coded Functional Identification Tapes (Continued)



Example Usage:

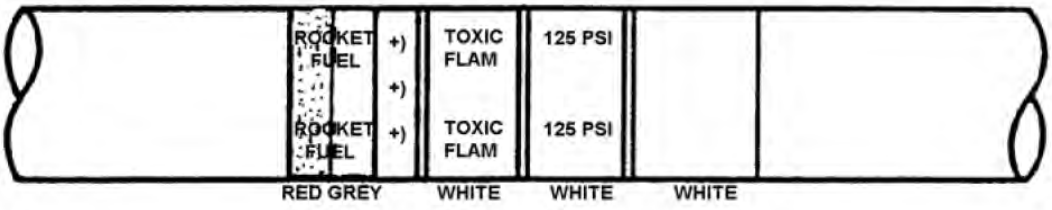


Figure 15. Color-Coded Functional Identification Tapes (Continued)

46. FLARING NONMETALLIC POLYAMIDE (NYLON) TUBING.

47. Flaring nonmetallic tubes is done at intermediate and depot levels. The following hand tools are required to flare nonmetallic tubes:

Support Equipment Required

Part No. or Type Designation	Nomenclature
—	Pneumatic Flaring Machine
—	Hand Flaring Tool
Steinel Model HL 1802E	Air Heat Gun Rated 120°F - 1100°F and 1500 watt or equivalent
—	Razor or Knife

a. Polyamide (nylon) tubing should be cut to required length using a razor, knife or equivalent cutting tool. The finished cut should be square with the end of the tube and free of debris.

b. If a tube is flared on both ends. Make sure nuts and sleeves are installed, before flaring. Nuts and sleeves should clear flaring tool.

c. Nylon tubing should be flared without lubrication.

d. Using Air Heat gun flaring and machine or tool assembly flare end(s) per the following steps:

(1) With Air Heat gun on a low setting, preheat 1/2" of tube end to be flared for 5-10 seconds or until material becomes pliable. Maximum temperature shall be 200°F. Rotate the tube by hand and heat evenly to prevent material from blistering.

CAUTION

Care should be taken to not use excessive flaring pressure to prevent material from squeezing between disks.

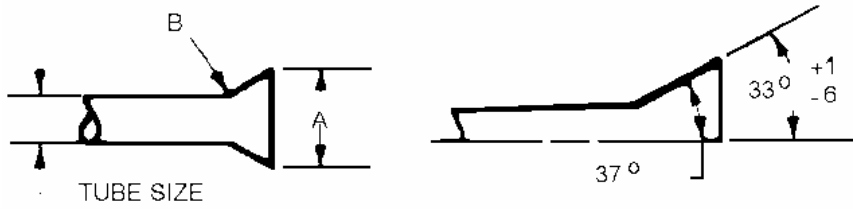
(2) Immediately insert tube in flaring machine or tool and flare using standard techniques.

(3) Cool tube in water bath at room temperature as quickly as possible.

(4) Inspect flare. Flare shall be square with tube centerline and within 5°, wall thickness shall be less than 75% of original thickness. Flares shall be free of pit marks and cracks (see Table 11).

(5) Normal safety precautions should apply using flared equipment.

Table 11. Polyamide (Nylon) Tubing Flare Dimensions



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TUBE SIZE (O.D.) (Inch)	"A" DIA. (Inch) + .000 - .010	"B" RADIUS (Inch) ± .010
1/8	.200	.032
1/4	.359	.032
3/8	.484	.046

Flares shall be square with tube C_L within 5°. Wall thickness of flare shall not be less than 75% of original wall thickness. Flares shall be free of pit marks.

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

FABRICATION

CLEANING, OXYGEN SYSTEMS TUBING

AIR FORCE USE ONLY

Reference Material

Cleaning Compound, Aerospace Equipment MIL-PRF-87937
Cleaning, Compound, Solvent, Trichloroethane MIL-C-81302

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Record of Applicable Technical Directives

None

1. GENERAL.

2. This Work Package applies to Air Force only.

3. REMOVING OIL AND GREASE FROM OXYGEN (GASEOUS OR LIQUID) SYSTEM TUBING ASSEMBLIES. Exterior of oxygen lines already installed in an aircraft (prior to line removal).

4. PRE-CLEANED EXTERIOR OF OXYGEN LINES.

WARNING

The use of Isopropyl Alcohol, TT-I-735, or any other cleaner not listed in this Work Package will not be used to clean oxygen related items. A fire or explosion can result from the use of unauthorized cleaners on oxygen components.

CAUTION

Gloves. Clean, white, acrylonitrile gloves are required, and should be worn, to prevent contact of the hands with the cleaning solvent during operations such as cleaning the oxygen tubing and fittings or transferring the cleaning solvent from the supply containers to a squirt bottle. Also, gloves should be worn to prevent contact of skin oils and acids with tubing and fittings, cleaning equipment, and wrapping and packaging materials. An acceptable type is Markson Science Inc., Part No. 7760.

If the reason for removal of the line is a leak at the fitting, and the line is dirty, leave the system pressurized for cleaning to prevent cleaner from entering the system.

Depressurize oxygen line before removal.

NOTE

Nitrogen. Gaseous nitrogen used for drying must conform to Fed. Spec, A-A-59503, Type I. Some acceptable types are: (1) Air Products and Chemicals, Inc., Purified Grade Nitrogen, 99.998% Purity, in 14 to 280 cu. ft. cylinders; and (2) Linde Div., Union Carbide, Dry Grade Nitrogen, 18 to 300 cu. Ft. cylinders.

Trichlorotrifluoroethane (Freon), MIL-C-81302 7

a. Clean new metal end caps (used to prevent contaminants from entering the open system) with MIL-C-81302, Type I.

NOTE

MIL-PRF-87937 Type II is diluted at the ratio of 10 parts warm demineralized water to 1 part cleaner. This is the optimum solution; full strength MIL-PRF-87937 will not be as effective. A warm cleaning solution (100 - 120°F) cleans more efficiently.

Demineralized water must conform to ASTM D1193, Type II.

b. Aqueous Cleaning.

Cleaning Compound, MIL-PRF-87937 23

(1) Using a solution of 1 part MIL-PRF-87937, Type II cleaner to 10 parts demineralized water, clean the B-Nut, related fittings, i.e. each end of tubing and related parts contaminated with oil, dirt, or foreign materials. Use a plastic drip pan to prevent cleaner from entering other areas. Use a soft bristle brush to scrub the outside surface to remove the contamination. Do not allow soap solution to dry prior to rinsing.

(2) Rinse the cleaning solution off with demineralized water.

c. Dry with a clean Kimwipe, NSN 7920-00-965-1709, white lint-free cloth NSN 7920-00-634-2408 or blow dry with warm dry nitrogen. When dry, use a Kimwipe or cloth for a final wipe and look for contaminants picked up by the Kimwipe or cloth.

CAUTION

Always use clean, oil free tools on oxygen components. Use only metal caps and plugs to cap openings on oxygen systems. Use metal caps only once to prevent aluminum shavings from contaminating system. NEVER use plastic caps or plugs.

d. If there are no indications of contaminants, remove the oxygen line with precleaned tools after depressurizing the system. Use metal caps or plugs to close all openings. This will prevent contamination entering the open system.

e. If contaminants remain, do not open the system. Proceed with paragraph 5, “Final Clean.”

5. FINAL CLEAN OF EXTERIOR OXYGEN LINES.

WARNING

Always use solvents in well ventilated areas and wear proper personal protection equipment such as rubber gloves, aprons, glasses, breathing mask, etc.

CAUTION

Always use clean, oil-free, tools when working with oxygen systems. Clean tools with aqueous cleaner, MIL-PRF-87937, Type II or Ethanol (A-A-59282) to remove contamination when necessary. Never use MIL-C-81302 for tool cleaning.

NOTE

Military Specification MIL-C-81302, Type I is a Class One Ozone Depleting Substance and production is banned after 31 December 1995. However, its use can continue as long as there is a supply of the chemical. The AF/Navy will purchase a limited supply for future use to solvent clean Oxygen systems until a suitable substitute can be found. Only a limited supply will be purchased and its use will be closely regulated for use in cleaning only Oxygen systems components. Conservation of this product is absolutely mandatory. A waiver is required to use this product. (Note: This material was reinstated for acquisition in 1991)

Storage of bulk solvent will be in sealed containers. Solvent used by the mechanic on a daily basis will be put into plastic Teflon squeeze bottles (NSN 6640-0-125-6821) and stored in a cool place to prevent loss from evaporation. In areas where the ambient temperature is 80°F or higher, the use of a refrigerator (if available for industrial chemical storage) to maintain a temperature of 40-50°F will greatly reduce solvent loss.

Trichlorotrifluoroethane (Freon), MIL-C-81302 7

a. Use MIL-C-81302, Type I in a Teflon squeeze bottle (NSN 6640-01-125-6821) to accomplish the final cleaning.

b. Carefully squeeze bottle of MIL-C-81302, Type I on the area to be cleaned (minimize solvent use). Wipe clean with a dry Kimwipe or whit lint-free cloth.

c. Examine Kimwipe or white lint-free cloth. If contaminants are present, repeat step b until no contaminants are visible.

d. Remove the oxygen line with pre-cleaned tools and cap all openings with metal caps (cleaned per paragraph 4, step a, to prevent contamination from entering the system.

6. <u>REMOVING OIL AND GREASE FROM OXYGEN (GASEOUS OR LIQUID) SYSTEM TUBING ASSEMBLIES, INTERIOR AND EXTERIOR OF LOCALLY MANUFACTURED OXYGEN LINES.</u>

7. Depots may vapor degrease (using tetrachloroethylene solvent, ASTM D 4376-94) oxygen tubing . Proper vapor degreasing is assured by allowing the tubing and fittings to remain in the vapor degreaser for approximately 20 minutes or until it reaches the operating temperature of the vapor degreaser. If a vapor degreaser is not available, clean all oil, grease and foreign material from the tubing and fittings using one of the following methods below.

8. PRE-CLEAN, INTERIOR AND EXTERIOR OF LINES.

WARNING

The use of Isopropyl Alcohol, TT-I-735, or any other cleaner not listed in this Work Package will not be used to clean oxygen related items. A fire or explosion can result from the use of unauthorized cleaners on oxygen components.

Both pre-clean and final clean steps must be accomplished Failure to accomplish final cleaning may result in a fire or explosion.

CAUTION

Gloves. Clean, white, acrylonitrile gloves are required, and should be worn, to prevent contact of the hands with the cleaning solvent during operations such as cleaning the oxygen tubing and fittings or transferring the cleaning solvent from the supply containers to a squirt bottle. Also, gloves should be worn to prevent contact of skin oils and acids with tubing and fittings, cleaning equipment, and wrapping and packaging materials. An acceptable type is Markson Science Inc., Part No. 7760.

NOTE

Nitrogen. Gaseous nitrogen used for drying must conform to Fed. Spec, A-A-59503, Type I. Some acceptable types are: (1) Air Products and Chemicals, Inc., Purified Grade Nitrogen, 99.998% Purity, in 14 to 280 cu. ft. cylinders; and (2) Linde Div., Union Carbide, Dry Grade Nitrogen, 18 to 300 cu. Ft. cylinders.

MIL-PRF-87937 Type II is diluted at the ratio of 10 parts warm demineralized water to 1 part cleaner. This is the optimum solution; full strength MIL-PRF-87937 will not be as effective. A warm cleaning solution cleans more efficiently.

Demineralized water must conform to ASTM D1193, Type II.

a. Aqueous Cleaning.

Cleaning Compound, MIL-PRF-87937 23

(1) Clean the outside and inside of the tube and end connectors with warm solution of one part Military Specification, MIL-PRF-87937, Type II to 10 parts demineralized water. Scrub the tube interior with a long soft bristle brush saturated with the soap solution or cap one end, fill 1/2 of tube with soap solution cap the other end and shake the tube. Pour out soap solution and repeat one time. Do not allow soap solution to dry prior to rinsing.

(2) Rinse immediately with demineralized water to remove all traces of soap solution. Spraying from pressure nozzles and heating the water to 120°F promotes effective rinsing.

b. Two methods for drying the demineralized water from the tube are as follows:

(1) Remove rinse water and dry the line with dry nitrogen until a -40°F dew point is reached. An acceptable dew point meter is Cole Palmer Instrument Company, Cat No. H-37960-00 Humidity/dew-point/temperature meter.

(2) Place the tube in an oven and bake at 100 to 110°C (212 to 230°F) for two hours.

c. After tube is dry, accomplish Final Cleaning, paragraph 9, step b.

9. FINAL CLEANING, INTERIOR AND EXTERIOR OF LINES.

WARNING

Always use solvents in well ventilated areas and wear proper personal protection equipment such as rubber gloves, aprons, glasses, breathing mask, etc.

CAUTION

Do not put any plastic parts in oven.

NOTE

Military Specification MIL-C-81302, Type I is a Class One Ozone Depleting Substance and production is banned after 31 December 1995. However, its use can continue as long as there is a supply of the chemical. The AF/Navy will purchase a limited supply for future use to solvent clean Oxygen systems until a suitable substitute can be found. Only a limited supply will be purchased and its use will be closely regulated for use in cleaning only Oxygen systems components. Conservation of this product is absolutely mandatory. A waiver is required to use this product. (Note: This material was reinstated for acquisition in 1991)

Storage of bulk solvent will be in sealed containers. Solvent used by the mechanic on a daily basis will be put into plastic Teflon squeeze bottles (NSN 6640-0-125-6821) and stored in a cool place to prevent loss from evaporation. In areas where the ambient temperature is 80°F or higher, the use of a refrigerator (if available for industrial chemical storage) to maintain a temperature of 40-50°F will greatly reduce solvent loss.

Trichlorotrifluoroethane (Freon), MIL-C-81302 7

a. Clean new metallic end caps (used to cap tubing during cleaning) with MIL-C-81302, Type I.

b. With one end of the tube capped off, partially fill the tube (50-60%) with clean cleaning compound, Military Specification MIL-C-81302, Type I. Cap the remaining open end and shake the tube for one minute. The cleaning compound must be allowed to contact the entire inner surface of the tube. Repeat the cleaning procedure for a total of three separate washings with clean unused MIL-C-81302, Type I.

c. After the final wash remove the end caps and clean the tubing threads with MIL-C-81302, Type I.

Nitrogen, A-A-59503 8

d. Blow a stream of dry nitrogen through the tube to remove all traces of solvent.

e. The tube will be inspected for cleanliness by accomplishing the following steps. A long Q-tip or white lint free cloth swab can be used to swab the mouth and 3 or 4 inches inside the tube and examined under the black and white light for contamination. The black light lamp must supply long wave ultraviolet light of 3400-3800 angstroms. Some acceptable types are: (1) Ultra-Violet Products Inc., San Gabriel, CA, Blake Ray, Model B-100A; (2) Braun Chemical Co. Cat. No. 36550-1, Los Angeles, CA; (3) Fisher Scientific Co. Cat. No. 11-983-lov2, St. Louis, Mo: and (4) Scientific Glass Apparatus Co., Inc., Cat. No. L-3055, Bloomfield, NJ.

WARNING

Do not look directly at the ultraviolet light source as eye damage can result. Overexposure of the skin to ultraviolet light will result in “Skin Burn.”

(1) Black Light (Ultraviolet Light) Inspection:

(a) Black Light inspect all accessible surfaces which will be indirect contact with oxygen in service. No surface, Q-Tip or cloth should fluoresce (Ultraviolet light causes most hydrocarbons to fluoresce.) If any fluorescence is observed, indicating hydrocarbon presence, re-clean the part.

(b) This inspection must be accomplished in a dark room.

(2) White Light Inspection:

(a) Using a white light, inspect all accessible surfaces which will be in direct contact with oxygen in service. The surface, Q-Tip or cloth shall have no evidence of contaminants. If any contaminants are found, re-clean the part.

(b) Contaminants include oil, grease, ink, dye particulate or fibers on the surface.

NOTE

Intimate wrap is Teflon film, 2-5 mil. It is required as an intimate wrap for oxygen components when caps of the proper size or fit are not available. An acceptable type is Cadillac Plastic and Chemical Co., FEP

Fluorocarbon, 200-500 gauge, in 12 lb. Rolls, in wither 6 inch, 12 inch, or 18 inch widths. The film must be cleaned for oxygen service prior to use with MIL-C-81302, Type I.

f. After drying, cap or cover the tube ends. Bag and label “Oxygen Clean” to prevent contamination of the clean tube. If the tube ends are not capped prior to placing in a bag, intimate wrap to prevent direct contact of the tube openings with the plastic bag.

10. REMOVING OIL AND GREASE FROM OXYGEN (GASEOUS OR LIQUID) SYSTEM FITTINGS, INTERIOR AND EXTERIOR OF FITTINGS.

11. (Tees, elbows, crosses, etc.) Depots may vapor degrease (using Tetrachloroethylene solvent, ASTM D 4376-94) oxygen tubing and fittings. Proper vapor degreasing is assured by allowing the tubing and fittings to remain in the vapor degreaser for approximately 20 minutes or until it reaches the operating temperature of the vapor degreaser. If a vapor degreaser is not available, clean all oil, grease and foreign material from the tubing and fittings using one of the following methods below.

12. PRE-CLEAN, INTERIOR AND EXTERIOR OF FITTINGS.

WARNING

The use of Isopropyl Alcohol, TT-I-735, or any other cleaner not listed in this Work Package will not be used to clean oxygen related items. A fire or explosion can result from the use of unauthorized cleaners on oxygen components.

Both Pre-clean and Final clean steps must be accomplished. Failure to accomplish Final cleaning may result in a fire or explosion.

CAUTION

Gloves. Clean, white, acrylonitrile gloves are required, and should be worn, to prevent contact of the hands with the cleaning solvent during operations such as cleaning the oxygen tubing and fittings or transferring the cleaning solvent from the supply containers to a squirt bottle. Also, gloves should be worn to prevent contact of skin oils and acids with tubing and fittings, cleaning equipment, and wrapping and packaging materials. An acceptable type is Markson Science Inc., Part No. 7760.

NOTE

Nitrogen. Gaseous nitrogen used for drying must conform to Fed. Spec, A-A-59503, Type I. Some acceptable types are: (1) Air Products and Chemicals, Inc., Purified Grade Nitrogen, 99.998% Purity, in 14 to 280 cu. ft. cylinders; and (2) Linde Div., Union Carbide, Dry Grade Nitrogen, 18 to 300 cu. Ft. cylinders.

MIL-PRF-87937 Type II is diluted at the ratio of 10 parts warm demineralized water to 1 part cleaner. This is the optimum solution; full strength MIL-PRF-87937 will not be as effective.

a. Aqueous Cleaning.

Cleaning Compound, MIL-PRF-87937 23

(1) Clean tees, elbows, crosses, etc., as required, which are contaminated with oil, dirt, foreign materials, etc., with a solution of 1 part MIL-PRF-87937, Type II, to 10 parts demineralized water. Use a soft bristle brush to scrub the outside surface to remove the contamination. Do not allow the soap solution to dry.

(2) Rinse the cleaning solution with demineralized water.

Nitrogen, A-A-59503 8

b. Dry with a clean Kimwipe, NSN 7920-00-965-1709, white lint-free cloth, NSN 7920-00-634-2408 or blow dry with warm dry nitrogen.

c. Use a clean Kimwipe or cloth for a final wipe. Examine the Kimwipe or cloth for contaminants and if contaminants remain repeat steps a, b, and c.

d. Accomplish Final clean, paragraph 13.

13. FINAL CLEAN, INTERIOR AND EXTERIOR OF FITTINGS

WARNING

Always use solvents in well ventilated areas and wear proper personal protection equipment such as rubber gloves, aprons, glasses, breathing mask, etc.

NOTE

Military Specification MIL-C-81302, Type I is a Class One Ozone Depleting Substance and production is banned after 31 December 1995. However, its use can continue as long as there is a supply of the chemical. The AF/Navy will purchase a limited supply for future use to solvent clean Oxygen systems until a suitable substitute can be found. Only a limited supply will be purchased and its use will be closely regulated for use in cleaning only Oxygen systems components. Conservation of this product is absolutely mandatory. A waiver is required to use this product. (Note: This material was reinstated for acquisition in 1991)

Storage of bulk solvent will be in sealed containers. Solvent used by the mechanic on a daily basis will be put into plastic Teflon squeeze bottles (NSN 6640-0-125-6821) and stored in a cool place to prevent loss from evaporation. In areas where the ambient temperature is 80°F or higher, the use of a refrigerator (if available for industrial chemical storage) to maintain a temperature of 40-50°F will greatly reduce solvent loss.

Trichlorotrifluoroethane (Freon), MIL-C-81302 7

a. Clean new end caps (if applicable) with MIL-C-81302, Type I.

b. Clean tees, elbows, crosses, etc. as required with MIL-C-81302, Type I. Ensure that threads and connectors are thoroughly cleaned.

Nitrogen, A-A-59503 8

c. Blow a stream of dry nitrogen through the parts to remove all traces of solvent.

d. The fittings will be inspected for cleanliness by accomplishing the following steps below. A long Q-tip or white lint free cloth swab can be used to swab the mouth and 3 or 4 inches inside the tube and examined under the black and white light for contamination. The black light lamp must supply long wave ultraviolet light of 3400-3800 angstroms. Some acceptable types are: (1) Ultra-Violet Products Inc., San Gabriel, CA, Blake Ray, Model B-100A; (2) Braun Chemical Co. Cat. No. 36550-1, Los Angeles, CA; (3) Fisher Scientific Co. Cat. No. 11-983-lov2, St. Louis, Mo: and (4) Scientific Glass Apparatus Co., Inc., Cat. No. L-3055, Bloomfield, NJ.

WARNING

Do not look directly at the ultraviolet light source as eye damage can result. Overexposure of the skin to ultraviolet light will result in “Skin Burn.”

(1) Black Light (Ultraviolet Light) Inspection:

(a) Black Light inspect all accessible surfaces which will be indirect contact with oxygen in service. No surface, Q-Tip or cloth should fluoresce (Ultraviolet light causes most hydrocarbons to fluoresce.) If any fluorescence is observed, indicating hydrocarbon presence, re-clean the part.

(b) This inspection must be accomplished in a dark room.

(2) White Light Inspection:

(a) Using a white light, inspect all accessible surfaces which will be in direct contact with oxygen in service. The surface, Q-Tip or cloth shall have no evidence of contaminants. If any contaminants are found, re-clean the part.

(b) Contaminants include oil, grease, ink, dye particulate or fibers on the surface.

e. If applicable, cap the ends.

NOTE

Intimate wrap is Teflon film, 2-5 mil. It is required as an intimate wrap for oxygen components when caps of the proper size or fit are not available. An acceptable type is Cadillac Plastic and Chemical Co., FEP Fluorocarbon, 200-500 gauge, in 12 lb. Rolls, in wither 6 inch, 12 inch, or 18 inch widths. The film must be cleaned for oxygen service prior to use with MIL-C-81302, Type I.

f. Bag capped parts or if parts are not capped, place an intimate wrap over all openings that come in direct contact with oxygen to prevent direct contact of the openings with the plastic bag. Label bag “Oxygen Clean.”

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

MAINTENANCE

TUBE ASSEMBLIES

Reference Material

Tubing, Tube Assemblies, and Fittings, Description WP008 00
Tube Assemblies, Fabrication WP009 00
Permaswage Fittings, Description and Maintenance WP011 00
Dynatube Fittings, Description and Maintenance WP013 00
Cryofit Fittings, Description and Maintenance WP016 00
Clamp, Loop, Cushion, General Specification for MIL-C-85052
Hydraulic Systems, Aircraft, Requirements for Design and Installation ..... SAE AS 5440
Inspection, Liquid Penetrant ..... ASTM E 1417
Pipe Threads, Taper, Aeronautical National Form, Symbol Aeronautical National Taper Pipe Threads (ANPT) General Requirements for ..... SAE AS 71051
Screw Threads, Standard, Optimum Selected Series: General Specification for MIL-S-7742
Tubing, Aluminum Alloy, Drawn, Seamless WW-T-700/4

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Record of Applicable Technical Directives

None

1. GENERAL.

2. Maintenance of tube assemblies at the organizational level is limited to inspection, removal, installation, repair and replacement.

3. INSPECTION.

4. Inspections shall be performed during fabrication, installation, and on in-service equipment as follows:

a Fabrication - inspect bulk tubing and fittings before and during fabrication of a tube assembly.

b. Installation - inspect tube assembly before and after installation.

NOTE

Find the cause of failure before replacing a defective tube assembly.

c. In-service - inspect tube assembly at regular intervals in accordance with applicable maintenance directives.

5. TUBING DAMAGE (3,000 PSI OR LESS). When inspecting for damage of tube and tube assemblies, inspect chafing, galling, or fretting, which may reduce ability of tubing to withstand internal pressure and vibration. Replace tubing which shows chafing, gal-ling, or fretting damage in excess of limits presented in Table 1.

a. Damage such as chafing, galling or fretting produces mechanical property changes in metal tubing material that greatly reduces the ability to withstand internal pressure and vibration. Any visible penetration of the tube wall surface (i.e., any visible damage to or removal of metal from the tube wall) by chafing, galling or fretting is cause for :

(1) Correction of the conditions that originated the damage.

(2) Replacement of the tube assembly or damaged section thereof regardless of the type metal, system media, or pressure ranges involved.

Titanium tubing with any nicks or scratches deeper than the values listed on Table 1 shall be replaced. Steel and aluminum alloy tubing manufactured from material listed in Table 1 which has nicks or scratches penetrating more than 15 per-cent of wall thickness shall be replaced.

6. Acceptable Limit of 3,000 psi Tubing Damage. Nicks, scratches, or dents caused by careless handling of tools are acceptable if they meet the following requirements:

a. Any dent which has a depth less than 20 percent of the tubing diameter is acceptable, unless the dent is on the heel of a short bend radius.

b. Titanium tubing with any nicks or scratches deeper than the values listed in Table 1 shall be replaced. A nick or scratch which has a depth of less than 15 percent of the wall thickness of aluminum alloy, or steel tubing shall be reworked by burnishing with hand tools before it is acceptable.

7. TUBING DAMAGE (PRESSURE AND RETURN TUBES FOR AIRCRAFT WITH 5,000 PSI HYDRAULIC SYSTEMS). When inspecting for damage of tube and tube assemblies, inspect chafing, galling, or fretting, which may reduce ability of tubing to withstand internal pressure and vibration.

Titanium tubing with nicks or scratches deeper than the values listed on Table 2 shall be replaced.

a. Tubing damage caused by careless handling of tools with a nick or a scratch deeper than the values listed in Table 2 shall be replaced.

b. Replace tubing which shows chafing, galling, or fretting damage in excess of the limits presented in Table 2.

c. Replace tubing with dent damage if the dent is on the heel of a short bend radius or if the dent is in excess of the limits presented in Table 2.

d. Damage such as chafing, galling or fretting produces mechanical property changes in metal tubing material that greatly reduces the ability to withstand internal pressure and vibration. Any visible penetration of the tube wall surface (i.e., any visible damage to or removal of metal from the tube wall) by chafing, galling or fretting is cause for :

(1) Correction of the conditions that originated the damage.

(2) Replacement of the tube assembly or damaged section thereof regardless of the type metal, system media, or pressure ranges involved.

Table 1. Allowable Tube Defect Depth-Hydraulic Pressure (3000 psi) and Return Lines (1500 psi)

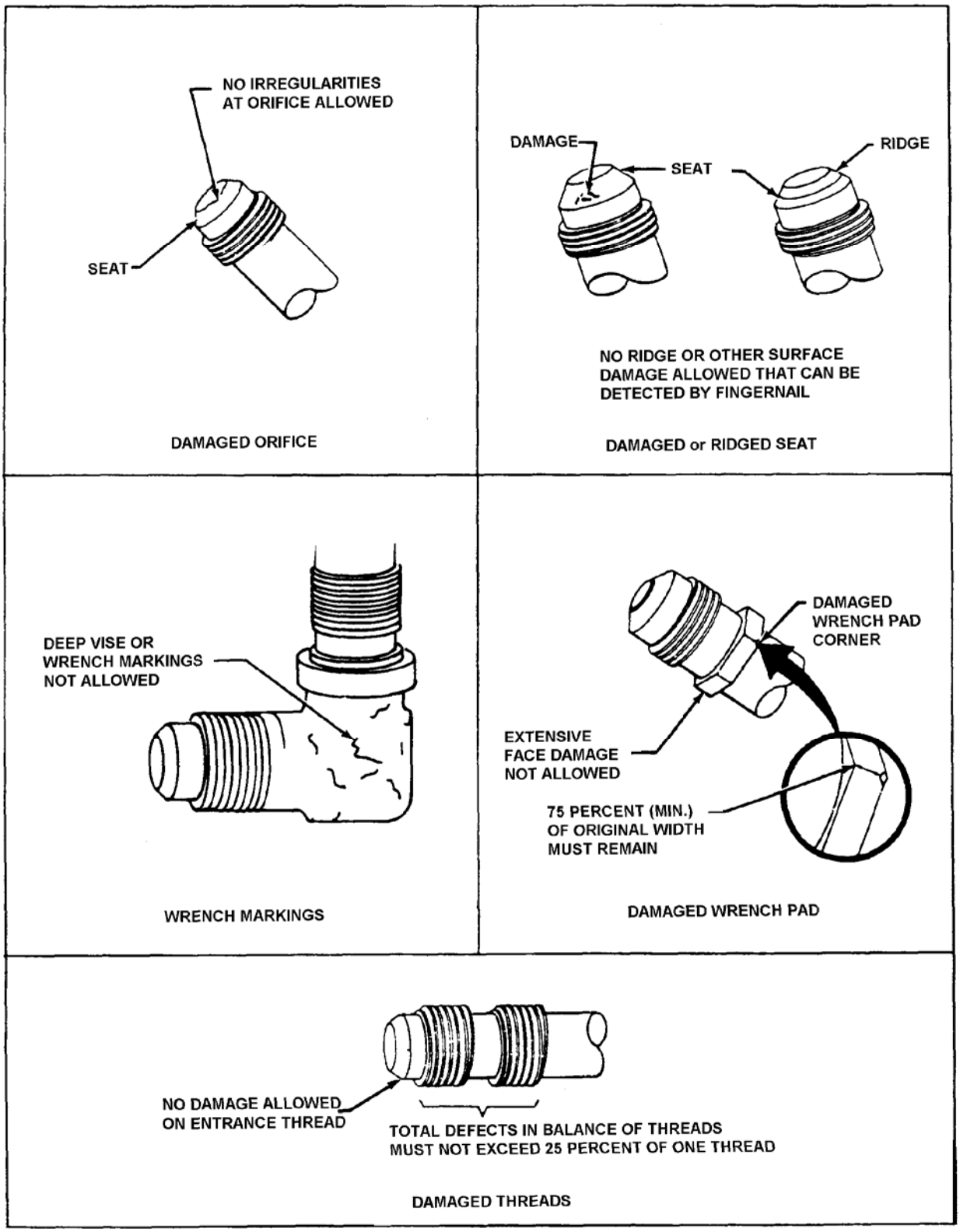
Tube Material (Pressure)	Defect Type	Tube OD (Note 1)						
		1/4	3/8	1/2	5/8	3/4	1	1 1/4
TI-3-AL-2.5V Material (3000 psi)	Chafed	.006	.007	.008	.010	.011	.012	—
	Dented	.005	.007	.010	.015	.018	.020	—
304 1/8H (3000 psi)	Chafed	.006	.007	.008	.010	.011	.012	—
	Dented	.005	.010	.020	.030	.040	.040	—
6061T6 (1500 psi Except Suction Line)	Chafed	.015	.015	.010	.005	.004 .015 (Note 2)	.003 .015 (Note 2)	.003 .015 (Note 2)
	Dented	.015	.015	.010	.005	.005	.005	.005

Notes: 1. All dimensions are in inches.
2. Suction line.

Table 2. Allowable Tube Defect Depth - V-22 and F/A 18 E/F

Tube Material (Pressure)	Defect Type	Tube OD (Note 1)						
		1/4	3/8	1/2	5/8	3/4	1	1 1/4
TI-3-AL-2.5V Material (5000 psi) (Note 2)	Chafed	.002	.002	.002	.003	.003	.003	—
	Dented	.002	.002	.002	.003	.003	.003	—
TI-3-AL-2.5V V-22 return line	Chafed	.002	.002	.002	.002	.002	.002	—
	Dented	.002	.002	.002	.002	.002	.002	—
TI-3-AL-2.5V F/A-18 E/F return line	Chafed	.006	.007	.008	.010	.011	.012	.012 (Note 3)
	Dented	.005	.007	.010	.015	.018	.020	.020 (Note 3)

Notes: 1. All dimensions are in inches.
2. Identical tubing for V-22 and F/A-18 E/F pressure systems.
3. Suction line.



010001

Figure 1. Damaged Fittings

8. TUBE FITTINGS. Before fittings are installed, inspect each fitting as follows:

a. Visually or flow check that fitting passage or passages are free from obstructions (Figure 1).

b. All rework fittings shall be inspected by Fluorescent Penetrant Method ASTM E 1417 or other approved inspection procedure. After Fluorescent Penetrant Inspection, serviceable fittings shall be treated to protect against corrosion.

9. INSTALLATION.

Materials Required

Specification or Part Number	Nomenclature
A-A-58092	Antiseize Tape
MIL-PRF-16173, Class II, Grade 2	Corrosion Preventive Compound
SAE AMS-S-8802	Sealant

10. Before installing tube assemblies, check the following:

a. Dents, nicks, and scratches as described above.

b. Correct nuts and sleeves.

c. Proper fit, where fitting is flared.

d. Proof pressure test of each assembly in accordance with WP009 00.

e. Cleanliness of assemblies in accordance with WP009 00.

11. TUBE ASSEMBLIES. Install tube assemblies as follows:

a. Hand-screw nuts onto mating connector.

b. Align tube assembly in place so that it will not be necessary to pull tube assembly into place with the nut.

NOTE

Tubing which runs through cutouts shall be installed to avoid scarring when the tubing is worked through a hole. If tube assembly is long, tape edges of cutouts before installing the assembly.

c. Torque nuts.

d. Apply protective coating to remaining non-sealed joints after tubing is installed.

Sealant, SAE AMS-S-8802 **11**

(1) For disconnected nonseal joints, apply SAE AMS-S-8802, followed by appropriate paint system if required.

Corrosion Preventive Compound, MIL-PRF-16173, Class II, Grade 2 **12**

(2) For connected nonseal joints, apply one coat of MIL-PRF-16173, Class II, Grade 2.

12. FLARED TUBE ASSEMBLIES. Correct and incorrect methods of installing flared tube assemblies are shown in Figure 2. Torque values, depending on type of fitting assembly material, are given in Table 3.

13. Common Causes of Flared Tube Assembly Leakage. Leakage of a flared tube assembly is usually caused by the following.

a. Flare distorted into the nut threads.

b. Sleeve cracked.

c. Flare out of round.

d. Flare cracked or split.

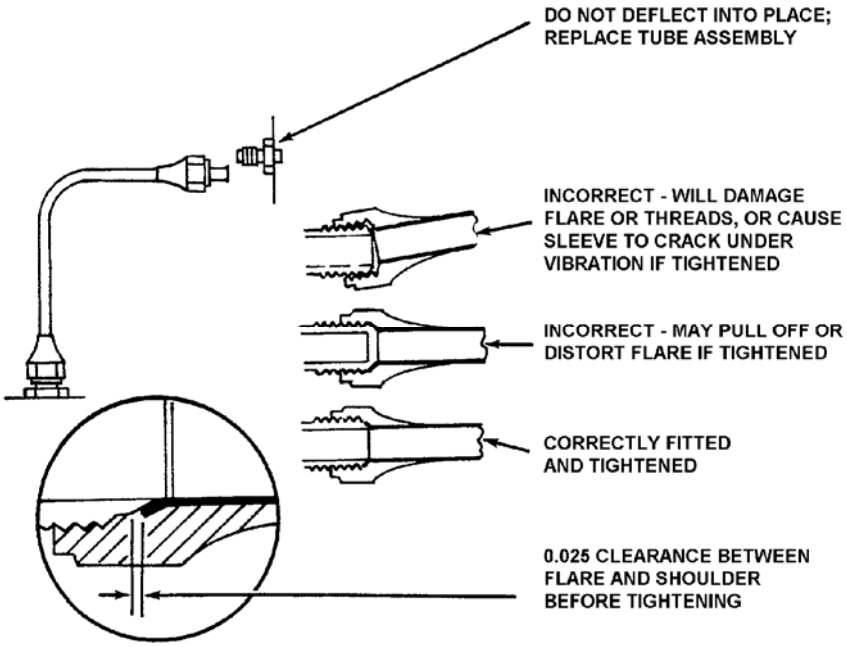
e. Inside of flare rough or scratched.

f. Connector mating surface rough or scratched.

g. Connector threads or nut dirty, damaged, or broken.

CAUTION

Do not tighten a nut when there is pressure in the line. Do not overtighten a leaking aluminum alloy assembly. Overtightening may severely damage or cut off tubing flare, or damage sleeve or nut. Undertightening of connections could cause tubing to leak at the connector because of insufficient grip on the flare by the sleeve. Use a torque wrench to prevent undertightening.



010002

Figure 2. Correct and Incorrect Method of Installing Flared Fittings

Table 3. Torque Values for Different Tubing Materials

Torque Values for Material AMS-T-6845 Type 304 1/8 Hard			
		Torque (in lb) ±5%	
OD and Wall	Preset Turns	Flareless	Flared
1/8 x .028	1 1/6	30	40
3/16 x .020	1 1/3	40	40
3/16 x .028	1 1/3	70	50
3/16 x .035	1 1/3	50	50
1/4 x .016	1	70	90
1/4 x .028	1 1/6	75	50
1/4 x .035	1 1/6	120	80
5/16 x .028	1 1/3	100	90
5/16 x .035	1	150	100
3/8 x .020	1	150	150
3/8 x .035	1	150	150
1/2 x .028	1 1/2	150	200
5/8 x .028	1 1/6	480	480
5/8 x .035	1 1/6	480	540
5/8 x .042	1 1/6	420	480
3/4 x .020	1 1/3	480	480
3/4 x .035	1 1/6	540	600
3/4 x .042	1 1/6	540	600
3/4 x .049	1 1/3	900	600
1 x .049	1 1/3	900	900
1 x .058	1 1/3	720	720
1 1/4 x .028	1 1/3	900	900

Table 3. Torque Values for Different Tubing Materials (Cont)

Torque Values for Material MIL-T-8504 Type 304 Annealed			
		Torque (in lb) ± 5%	
OD and Wall	Preset Turns	Flareless	Flared
3/16 x .020	1 1/6	65	50
1/4 x .020	1 1/6	80	80
1/4 x .035	1 1/6	90	100
3/8 x .028	1	140	150
3/8 x .049	1	120	150
1/2 x .028	1 1/2	300	125
1/2 x .035	1 1/6	300	300
5/8 x .035	1 1/6	480	480
3/4 x .035	1 1/6	480	540
3/4 x .049	1 1/3	600	600

Torque Values for Material AMS 5556 or AMS 5557 Type 321			
		Torque (in lb) ± 5%	
OD and Wall	Preset Turns	Flareless	Flared
1/4 x .028	1	70	100
1/4 x .035	1	110	60
1/4 x .049	1 1/6	100	100
3/8 x .020	1	110	110
3/8 x .028	1 1/6	200	180
3/8 x .035	1	110	130
1/2 x .028	5/6	300	300
1/2 x .035	5/6	280	270
5/8 x .020	1	200	200
5/8 x .035	1	300	360
1 1/4 x .035	1 1/6	780	600

Torque Values for Material AMS 5556 or AMS 5557 Type 347			
		Torque (in lb) ± 5%	
OD and Wall	Preset Turns	Flareless	Flared
1/2 x 0.020	1	300	200
3/4 x 0.020	1	450	400
3/4 x 0.035	1	540	420
3/4 x 0.049	1 1/6	720	600
1 x 0.020	1	600	600
1 x 0.028	1	700	600
1 x 0.035	1 1/3	600	600

Table 3. Torque Values for Different Tubing Materials (Cont)

Torque Values for Material Titanium (Grumman) 3AL-2.5V			
		Torque (in lb) ± 5%	
OD and Wall	Preset Turns	Flareless	Flared
3/8 x .022	1 1/6	190	190
3/8 x .028	1	160	150
1/2 x .016	1	170	250
1/2 x .028	1 1/6	390	350
5/8 x .035	1 1/6	480	480
3/4 x .043	1	480	600
1 x .057	1 1/6	720	900

Torque Values for Material CRES 21-6-9 (Lockheed)			
		Torque (in lb) ± 5%	
OD and Wall	Preset Turns	Flareless	Flared
1/4 x .016	1 1/6	90	75
3/8 x .020	1	150	150
1/2 x .020	1 1/2	250	300
1/2 x .026	1 1/3	360	420
5/8 x .020	1 1/6	420	600
5/8 x .033	1 1/3	400	480
3/4 x .020	1 1/2	540	600
1 x .026	1 1/3	600	720

Torque Values for Material Aluminum WW-T-700 (5052-0 Annealed)			
		Torque (in lb) ± 5%	
OD and Wall	Preset Turns	Flareless	Flared
1/4 x .028	1	100	70
1/4 x .035	1	40	50
1/4 x .049	1	30	50
5/16 x .035	2/3	65	65
3/8 x .028	1/2	90	60
3/8 x .035	1	80	80
3/8 x .049	1	160	120
1/2 x .035	1	160	160
1/2 x .042	1	170	170
1/2 x .049	1 1/6	270	250
1/2 x .065	1	220	220
5/8 x .035	1 1/6	240	150
5/8 x .042	5/6	250	250
5/8 x .049	5/6	250	250
3/4 x .035	5/6	300	360
3/4 x .049	1	250	300
1 x 0.020	1	600	600
1 x 0.028	1	700	600
1 x .035	1 1/3	540	480
1 x .049	1	480	360

Table 3. Torque Values for Different Tubing Materials (Cont)

Torque Values for Material Aluminum WW-T-700/6D (6061-T6)			
OD and Wall	Preset Turns	Torque (in lb) ± 5%	
		Flareless	Flared
1/4 x .035	1	85	60
5/16 x .028	5/6	50	50
5/16 x .035	2/3	80	70
3/8 x .035	1 1/6	170	140
3/8 x .058	1	160	140
1/2 x .028	1	200	200
1/2 x .035	5/6	240	240
1/2 x .049	1	175	300
1/2 x .065	1	310	270
5/8 x .028	2/3	200	300
5/8 x .035	5/6	250	300
3/4 x .035	1	360	420
3/4 x .065	1	420	600
1 x .028	1	360	480
1 x .035	1 1/6	576	480
1 x .065	1	600	720
1 1/4 x .035	1 1/3	720	840

14. Tightening Flared Tube Assembly. If an aluminum alloy flared tube assembly leaks after tightening to required torque, disassemble tube assembly for repair or replacement. If a steel flared tube assembly leaks, it may be tightened 1/16 turn beyond noted torque. If the assembly continues to leak, it shall be disassembled for repair or replacement.

15. FLARELESS TUBE ASSEMBLIES. When installing flareless tube assemblies, proceed as follows:

a. Make sure no nicks or scratches are evident and sleeve is preset.

b. Tighten nut by hand until resistance to turning develops.

CAUTION

Do not use pliers to tighten tube connectors.

NOTE

If it is impossible to use fingers to run nut down, use a wrench, and look out for the first signs of bottoming.

Although a hand presetting tool is desirable (See Table 4), a standard flareless fitting body can be used. An aluminum fitting should be used only once for presetting and a steel body should be used no more than five times.

c. Final tightening shall begin at point where nut begins to bottom.

NOTE

Use torque wrench if fitting is accessible and torque fitting to values prescribed in Table 3.

d. If connection is not accessible for torque wrench, proceed as follows:

NOTE

A 1/6 turn equals the travel of one flat on a hex nut.

(1) Use a wrench to turn nut 1/6 turn while holding connector with another wrench to prevent connector from turning.

(2) Tighten nut an additional 1/6 turn if connector leaks.

(3) Loosen and completely disconnect nut if leak continues. Inspect fitting components for scores, cracks, foreign material, or damage from previous overtightening.

Table 4: Hand Presetting Tool

Weatherhead Part Number	Dash Size	Tube Outside Diameter
270-00202	-2	1/8
270-00203	-3	3/16
270-00204	-4	1/4
270-00205	-5	5/16
270-00206	-6	3/8
270-00208	-8	1/2
270-00210	-10	5/8
270-00212	-12	3/4
270-00216	-16	1
270-00220	-20	1 1/4
270-00224	-24	1 1/2
270-00232	-32	2

CAUTION

Do not tighten fitting nut more than 1/3 of a turn (two flats on nut).

(4) Reassemble fitting, finger tighten nut and repeat wrench tightening of step d.(1).

(5) Remove nut and repeat steps d.(3) and d.(4), if leakage from an installed fitting is discovered.

16. TUBE FITTINGS. Fittings of various shapes and designs are illustrated in WP008 00. Installation procedures for specific fittings are described below. It is important to tighten tube fitting nuts properly. A fitting wrench or an open-end wrench should be used when tightening connections.

17. Installing Combination Bulkhead and Universal Tube Fittings. These fitting combinations (Figure 3) are used for connecting tubing systems. To install combination bulkhead and universal fittings, proceed as follows:

WARNING

No lubricant shall be used on line connections in oxygen systems.

a. Lubricate threads of nut and connector with lubricant specified in WP009 00.

b. Assemble nut on fitting end and screw nut back to clear gasket groove.

c. Position teflon washer and gasket or O-ring packing in gasket groove.

d. Screw fitting into boss until gasket or O-ring packing touches boss.

e. Unscrew fitting from boss not more than 360 degrees.

f. Tighten locknut lightly.

g. Connect flared tubing to fitting.

h. Tighten locknut against boss.

18. Installing Oxygen System Flared Tube Fittings. In low-pressure oxygen systems, only aluminum alloy flared fittings are used and the parts are joined by double-flared tube connections (Figure 4)

NOTE (AIR FORCE ONLY)

Air Force can use stainless steel fittings

a. Where 5/16-inch single-flared tubing is already installed, the fitting shall not be to a torque greater than 100 inch lb. If the leak cannot be stopped with initial 100 inch lb torque, replace tube assembly with a double-flared tubing assembly

b. (Double flared systems) (Table 5) A torque wrench with proper fitting adapter shall be used when tightening flared connections. If the leak cannot be

stopped with initial torque, replace tube assembly with a double-flared tubing assembly.

19. Torque Values. Torque values for oxygen flared tube fittings are listed in Table 5. When installing an oxygen flared tube assembly, torque fittings to their initial values. If tube assembly leaks during proof pressure testing (WP009 00), disconnect tube assembly from test stand and increase torque up to its maximum values (). Tighten fitting gradually. If maximum torque does not stop leak, replace fitting.

NOTE (AIR FORCE ONLY)

Depot level activities, including commercial contractors, effecting the overhaul, repair, or modification of service aircraft are prohibited from using anti-seize compounds on flared tubing threads. These activities will adhere to Military Specification MIL-I-5585, and will replace fittings that are manufactured to maximum or minimum thread tolerances.

a. **(AIR FORCE ONLY)** Prior to connecting a flared tubing assembly to a flared tubing fitting, the cone surface of the tubing assembly and the fitting should be wiped with a clean, dry cloth to remove any dust, dirt, or other foreign matter.

20. Installing Tube Fittings With Tapered Pipe Threads.

CAUTION

When installing pipe thread fittings, the fittings shall be tightened so as not to damage threads or crack the part in which the fitting is being installed.

Do not overtighten pipe fittings. Overtightening causes distortion, cracking and leaks. Pipe thread fittings of 1/8-inch size shall be torqued between 40 inch lb and 150 inch lb. Fittings of 1/4-inch size shall be torqued between 60 inch lb and 200 inch lb.

NOTE

Where minimum tolerance diameter female fittings mate with maximum tolerance diameter male fittings producing a close fit requiring lubrication of first thread, antiseize tape may be wrapped beginning with the first thread of male pipe.

Pipe threads shall conform to SAE AS 71051. Figure 5 shows the difference between a straight and pipe thread.

21. Installing Oxygen System Tubing And Support Equipment Tubing With Tapered Pipe Thread Fittings. The threaded portion of a pipe fitting is tapered so that when it is tightened, the part with the external thread (male) is forced into the internally threaded (female) part, creating a seal. Antiseize tape (Polytetrafluoroethylene) A-A-58092 may be used on pipe fittings as follows:

a. Clean male and female threads of all previously applied tape or compound.

b. Wrap antiseize tape tightly in direction of spiral of male pipe thread, beginning with the third thread in order to prevent cutting off loose pieces of tape.

NOTE

Where minimum tolerance diameter female fittings mate with maximum tolerance diameter male fittings producing a close fit requiring lubrication of first thread, anti-seize tape may be wrapped beginning with the first male pipe.

c. Antiseize tape shall encircle threads and join together with a slight overlap. Use size 1 tape, 1/4 inch wide for 1/8, 1/4 and 3/8-inch pipe threads. Do not use tape on fittings with flared or cone ends.

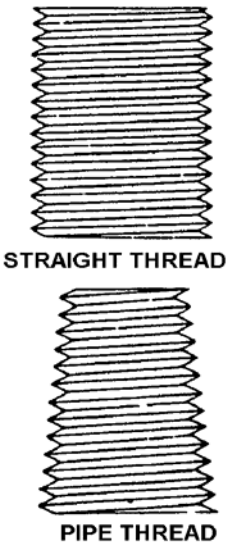


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Figure 5. Straight Thread and Pipe Thread

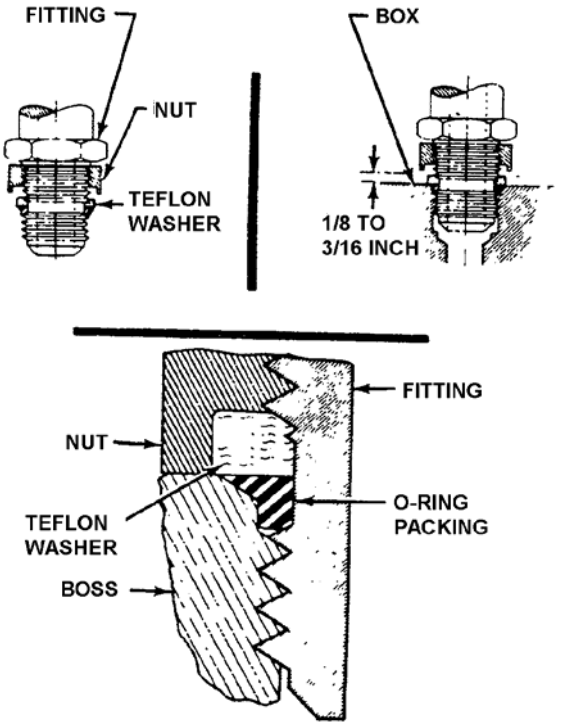

Figure 3. Combination Bulkhead and Universal Fitting Assembly

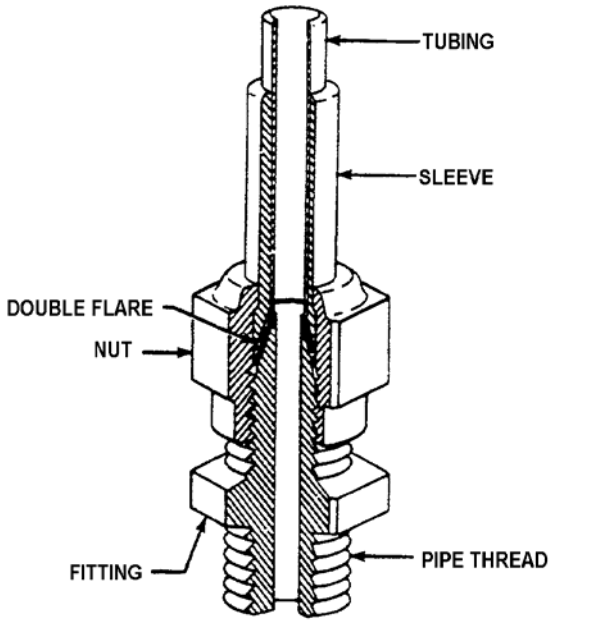

Figure 4. Double Flared Tubing Connection

Table 5. Torque Values of Oxygen Flared Tubing

Tubing OD	Torque (lb-in)			
	Aluminum		Steel	
	minimum	maximum	minimum	maximum
3/16 in			50	70
5/16 in (Note 1)	100	125	170	200
3/8 in	200	250	270	300
1/2 in	300	400	450	500
Notes: 1. Double-flared tubing only.				

22. GROMMETS AND CLIPS ON TUBING ASSEMBLIES. To prevent vibration and chafing, cushion clips shall be installed at 15-inch intervals as close to tubing bends as possible. Table 6 shows the maximum allowable distance between supports. Flexible grommets or hose shall be used at points where tubing passes through bulkheads. Unless otherwise specified, where tubing is supported to structure or other rigid members, a minimum clearance of 1/16 inch shall be maintained. In areas close to rigid structures or where relative motion of adjoining components exists, a minimum clearance of 1/4 inch shall be maintained.

23. INSTALLING CLAMPS. All hydraulic tubing shall be supported from rigid structures preferably by cushioned steel clamps MIL-C-85052 (Table 7) or multiple tube block clamps. Hydraulic tubing support clamps shall be installed and maintained in the positions described in Maintenance Instruction Manuals (MIMs) or applicable technical directives.

WARNING

Coil type chafe guard shall not be used on rigid tubing. It may result in abrasion and damage to the tubing. Use only methods specified in this manual.

24. Selecting Clamps. Selecting the correct size clamp is vital for a dependable tubing installation. A loose clamp will permit abrasion and often cause clamp breakage or even result in tube or fitting failure (Figure 6). The use of too small a clamp will likely result in a broken clamp and subsequent tubing or fitting failure. A 25-lb minimum tension for tubes where no movement is desired and a 10-lb maximum tension where movement is recommended.

25. Spacing Clamps. Spacing of clamps must be determined for each and every tube installation, taking into consideration load, flexure, vibration, surges and other operational factors. Specification SAE AS 5440 may be used as a guide in view of the other variables which can be involved (Table 8).

26. Mounting Clamps. The position of the clamp, relative to the tube, must be at 90 degrees at installation to prevent built-in preload and subsequent clamp distortion and failure (Figure 7). Clamp misalignment will also cause abrasion or tearing of the cushion material, resulting in a metal-to-metal condition, and a far greater abrasion problem. In some instances, due to flexure or line surge, clamp swivel is experienced, causing the distortion. Substitute a clamp with 2-hole mounting to eliminate this condition.

27. Clamping Bend Tubes. Tubing should be supported to rigid structure as close to the tube bends as possible, as this is an area of pressure buildup and surge, especially in hydraulic and fuel systems. As tubing is no longer perfectly round after bending, check the tube for roundness, before positioning the clamp and securing it to the structure. Clamping on the tube bend or out-of-round areas will distort the clamp, causing abrasion and subsequent clamp and tube failure. Locate the clamp mounting, where possible, to the inside of the bend for the best structural advantage (Figure 8).

28. Clamping Tubes Vertically. When mounting tubes to vertical structure, the static load force should oppose the mounting foot and bolt when using a single mounting point clamp. If the tube is mounted with the bolt below the tube, bending or distortion can and probably will result from either static load or personnel using the tubing as a handhold (Figure 9).

29. Clamping Tubes That Flex. When surges, loads or flexure occur on installations to vertical or horizontal structure, it is good practice to alternate the mounting points to provide maximum support in both directions (Figure 10). If conditions are severe, a saddle style clamp may be necessary. If surge or flexure is in only one direction, the mounting should oppose the force. When surge or movement is parallel to the center line of the tube, and the forces are sufficient to produce swiveling of single mounting point clamps, it becomes necessary to use 2-hole mountings.

30. Standoffs and Brackets. Standoffs and brackets are necessary for many tubing and wiring installations due to existing available structure and the line or cable separation required. Brackets are preferred over standoffs since they provide more support for the clamp and eliminate another piece of loose hardware, a principle cause of Foreign Object Damage (FOD). Standoffs should not be used under high-vibration and surge conditions as swiveling, cocking, and the high degree of clamp movement experienced with the cantilever-type mounting will ultimately result in clamp breakage. This same problem can result from cantilever mounting from brackets, however, to a lesser degree, since the bracket will provide greater support under the clamp foot (Figure 11).

31. Butterflying. The common practice of mounting two or more clamps with a single bolt, known as butterflying should be kept to a minimum. It not only increases maintenance costs, but in some cases requires standoffs which accentuate the problems (Figure 12). Brackets or base mounting are preferred.

Table 6. Maximum Distance Between Supports for Fluid Tubing, SAE AS 5440

Tubing OD (Note 1)	Distance Between Supports	
	Aluminum Alloy	Steel
1/8	9 1/2	11 1/2
3/16	12	14
1/4	13 1/2	16
5/16	15	18
3/8	16 1/2	20
1/2	19	23
5/8	22	25 1/2
3/4	24	27 1/2
1	26 1/2	30 1/2
1 1/4	28 1/2	31 1/2
1 1/2	29 1/2	32 1/2

Notes: 1. All diameters are in inches.

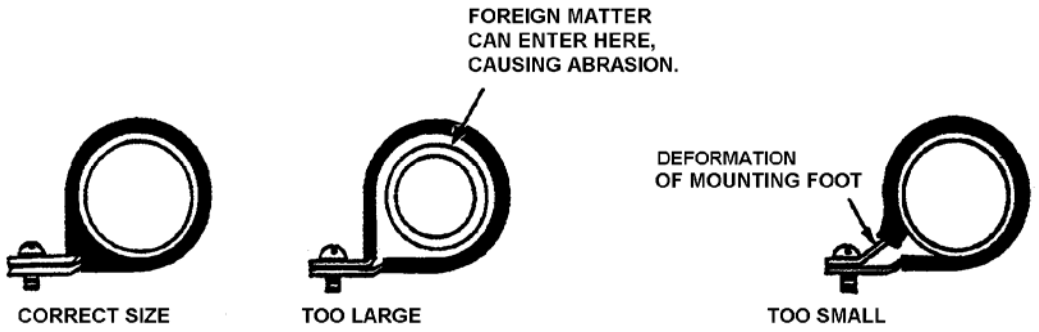

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Figure 6. Selecting Correct Size Clamp

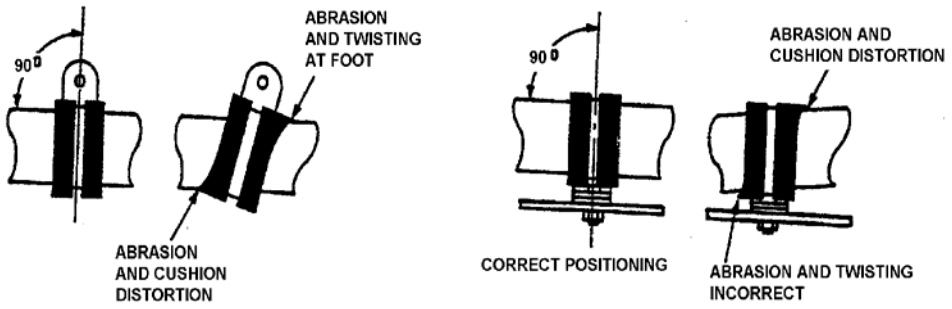

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Figure 7. Mounting Clamps

Table 7. Clamps

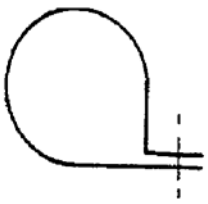
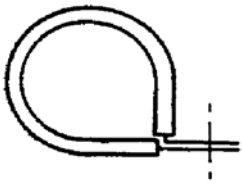
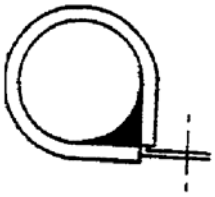
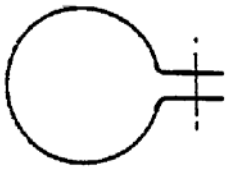
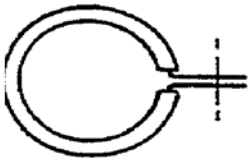
Clamp Style	Specification	Application Information
Loop Style - No Cushion  010t06a	AN742 MS9025 NASMS21322 MS122900 through MS122939	Used primarily for electrical bonding or grounding and in some instances for high temperatures in excess of cushion capabilities.
Loop Style - Cushioned  010t06b	MIL-C-85052 (heavy duty) MS21919 (light duty) NAS1715 NASMS21322 NAS1715	A clamp configuration for tube clamping available in a variety of metal bands and cushioning materials. For general purpose use on ground support and automotive equipment.
Loop Style Cushioned With Wedge  010t06c	MIL-C-85052 (heavy duty) MS21919 (light duty) NAS1715	The most widely used configuration for wire bundle, cable and tube clamping. Also available in a variety of metal bands and cushioning materials. Wedge dimensional requirements vary according to use. Refer to MIL-C-85052 for full contour wedge providing maximum tube retention.
Center Mount No Cushion  010t06d	AN735	Used for electrical bonding or grounding and in some applications where temperatures exceed cushion capabilities.
Center Mount Cushioned  010t06e	NAS1713	An excellent tube clamp providing excellent retention resulting from 360 degree contact. Also, can be used for cable installations. Not preferred for wire bundles as trapping of wires is possible.

Table 8. Guide for Spacing Clamps

Type	Spacing
Rigid Pressure Lines	10 - 12 inches
Rigid Return Lines	15 - 18 inches

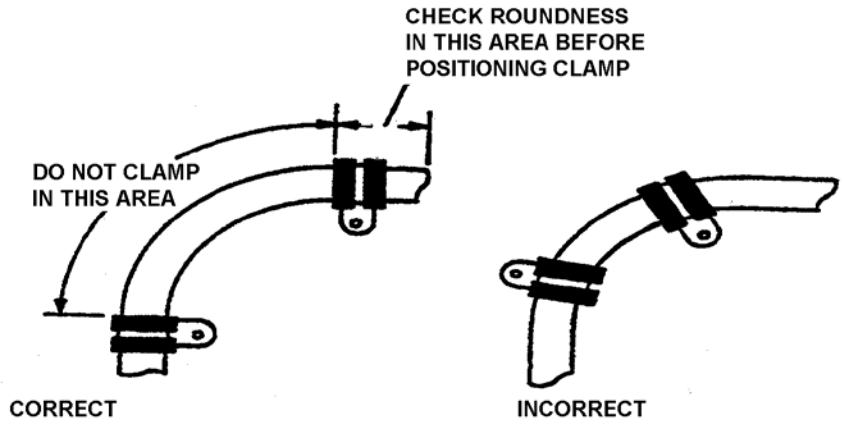


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Figure 8. Clamping Bend Tubes

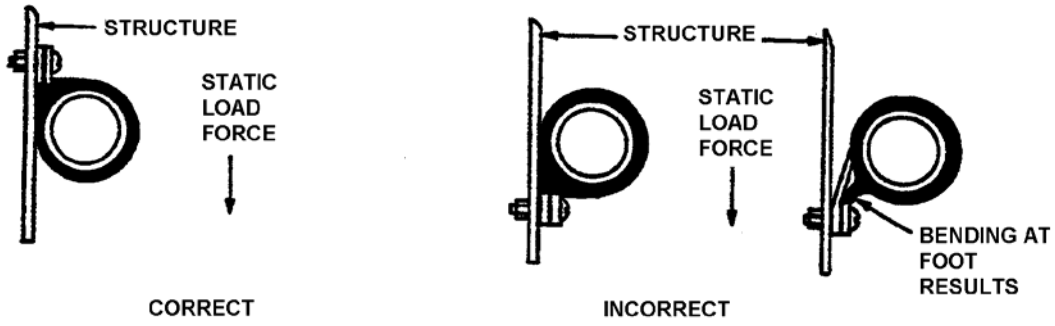

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Figure 9. Clamping Tubes Vertically

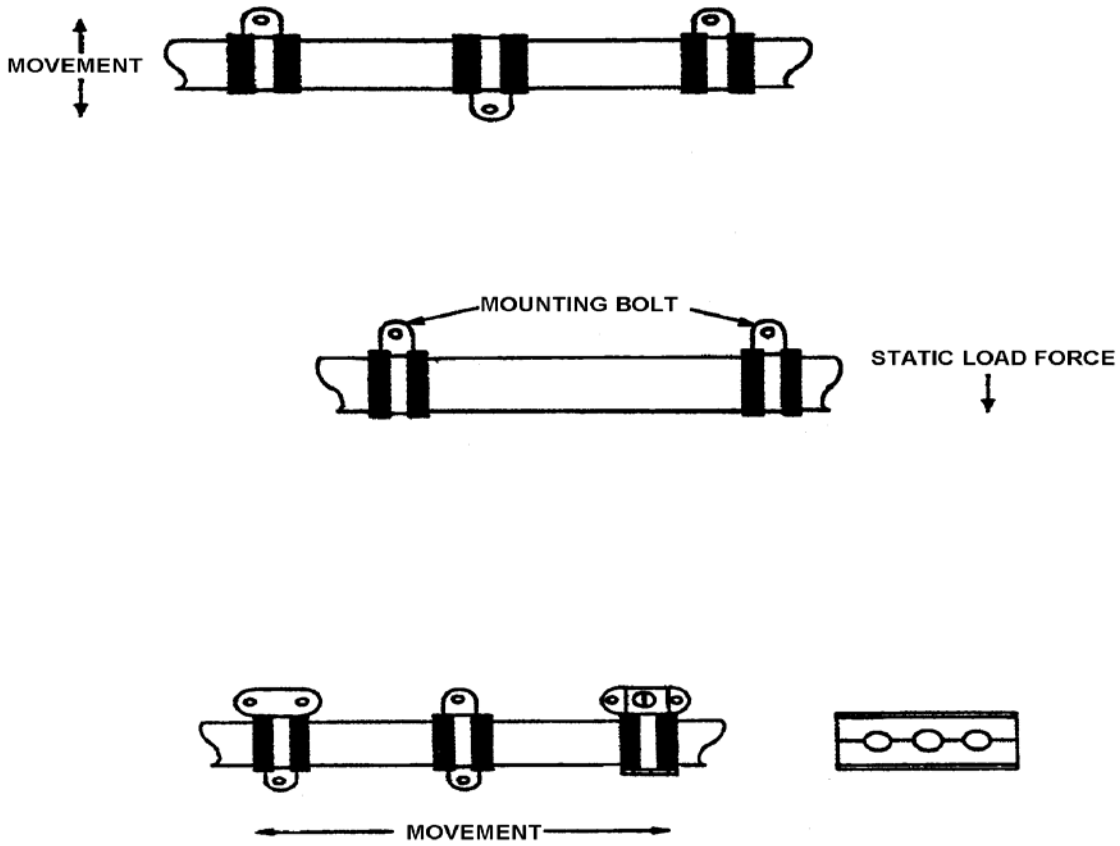

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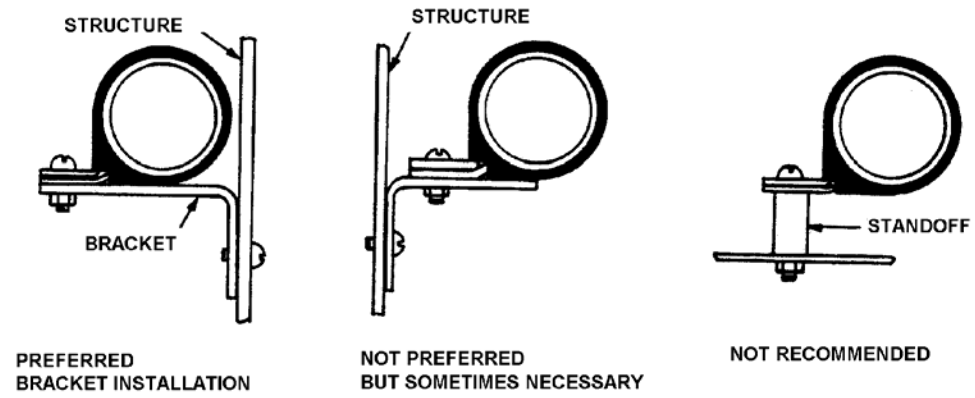
Figure 10. Clamping Tubes That Flex



NOTE:

1. EXCESSIVE MOVEMENT OR VIBRATION MAY CAUSE CLAMP BREAKAGE AT FOOT DUE TO CANTILEVERING.

010011

Figure 11. Standoffs and Brackets

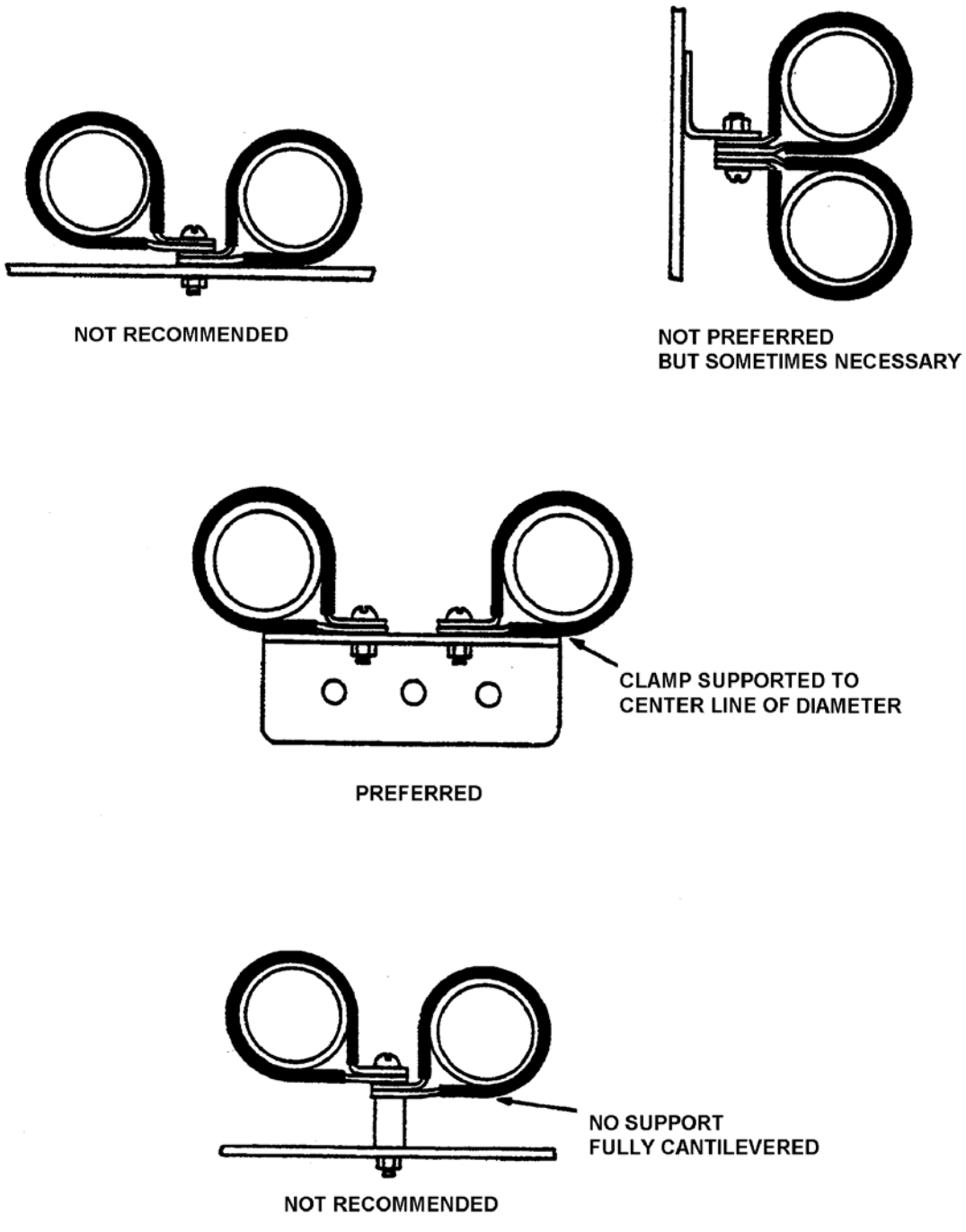


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Figure 12. Butterflying

32. REPAIR

a. **(NAVY ONLY)** Instructions for temporary repairs, paragraphs 34 and 35 are for Navy use only.

b. **(AIR FORCE ONLY)** Air Force repair procedures are presented in WP 010 01.

Materials Required

Specification or Part Number	Nomenclature
AN815	Union
AN818	Nut
AN819	Sleeve

33. Tube assembly repair is divided into two categories, temporary and permanent. The paragraphs below describe the difference between a temporary repair, a permanent repair, and the procedures required to make these repairs.

34. (NAVY ONLY) TEMPORARY REPAIR. For temporary repairs, splice sections fabricated with flared ends or preset MS sleeves are used. Splice sections are to be replaced by a permanent repair or new tubing assembly at the next rework cycle. Temporary or emergency repairs shall be limited to cases due to unavailability of equipment, material, or unusual circumstances. Temporary repairs are not allowed at Depot level maintenance activities.

35. **(N)** Procedure for temporary repair of damaged tubing. To make a temporary repair of damaged tubing, proceed as follows:

a. **(N)** Cut and remove damaged section of tubing.

b. **(N)** Remove rough edges of remaining tube ends.

c. **(N)** Clean tubing ends with a lint-free wiping cloth.

d. **(N)** Position nuts AN818 and sleeves AN819 on tubing ends (Figure 13).

e. **(N)** Flare tubing as described in WP009 00.

f. **(N)** Install unions AN815.

g. **(N)** Position nuts AN818 and sleeves AN819 on new section.

NOTE (NAVY ONLY)

A new section is not required when the length of the union is longer than the damaged section.

h. **(N)** Install new section of tubing and tighten nuts AN818.

36. PERMANENT REPAIR. Permanent repair includes removal of minor damage on tubing and fittings, and replacement of line section or fitting (WP011 00, WP013 00, and WP017 00). Repair by induction brazing (below) or Cryofit (WP016 00) is limited to Depot level.

37. Permanent Repair, Using Automatic Induction Brazing Equipment. Tube assemblies used for engine-related hydraulic, fuel, oil, vent or drain lines usually have brazed or welded end fittings. These engine-related tube assemblies are normally fabricated from Corrosion-Resistant Steel (CRES), supplied in the annealed condition under military specifications, AMS 5575, AMS 5576, MIL-T-8504, AMS-T-8506, AMS 5560, AMS 5563, AMS 5564, AMS 5565, AMS 5566, AMS 5567, AMS 5569, MIL-T-8606, AMS 5556, AMS 5557 and MIL-T-8973. Fabrication or repair of CRES tube assemblies, using automatic induction brazing at Depot level maintenance activities, or by approved vendors, using automatic controlled tube brazing equipment, shall be approved by cognizant Naval Air Depot or Naval Air System Command Head-quarters.

38. Permanent Repair of Minor Surface Damage to Tubing. Some minor surface damages to tubing are acceptable as described in Paragraph 6. A nick which is not deeper than 15 percent of the wall thickness of aluminum, aluminum alloy, or CRES is acceptable after being reworked by burnishing with hand tool.

39. Definitions of Minor Damage to Fittings. Minor damage to fittings is classified as follows:

CAUTION

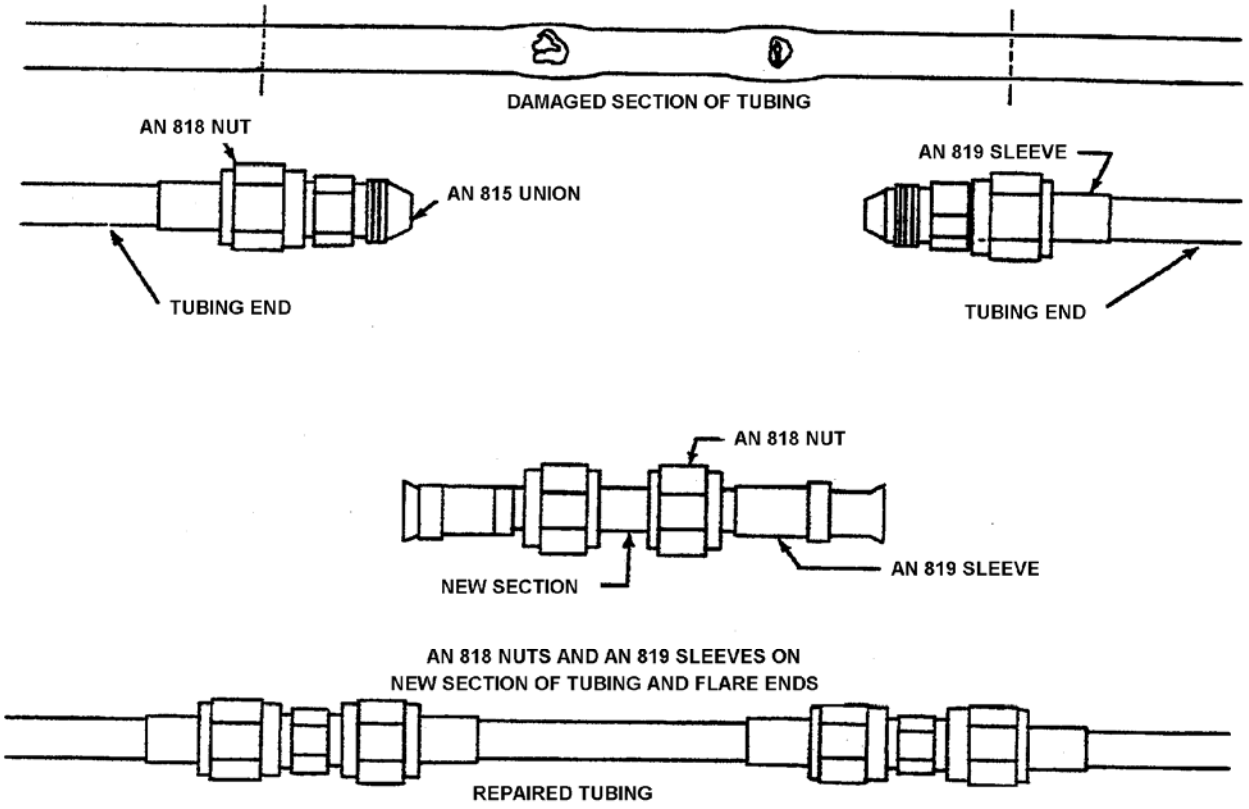
Fittings that exceed repairable limits as defined in Figure 14 shall be replaced.

a. Damaged orifice (Figure 14, detail A).

b. Damaged or ridged seat (Figure 14, detail B).

c. Damaged wrench pad (Figure 14, detail C).

d. Damaged threads (Figure 14, detail D).



010013

Figure 13. Temporary Tubing Repair

40. <u>Permanent Repair of Minor Damage to Fittings.</u> To repair the various damages of a fitting, proceed as follows:

a. To repair damaged orifices, remove any restriction in the orifice and handstone to blend rough edges or burrs (Figure 14, detail A).

b. To repair damaged or ridged seats, resurface circumferential ridges with annular tool (Figure 14, detail B).

NOTE

Tool marks, other than those of annular tools (one ten thousandth of an inch RMS) are permitted on sealing surface.

c. To repair damaged wrench pads, remove minor scratches with a fine file, leaving no file marks (Figure 14, detail C).

d. To resurface the 37-degree sealing surface, a minimum distance of 1/16 inch (.063) shall be maintained between the 37-degree sealing surface and the start of the first thread (Figure 14, detail E). Fitting threads shall conform to pitch diameter tolerance of class 2, MIL-S-7742.

41. <u>Reworked Fittings.</u> All reworked fittings shall be inspected and treated against corrosion as described in Paragraph 7. Reworked aluminum alloy fittings shall be anodized; however, uniform color of reworked fittings after anodizing is not necessary.

WARNING

Oxygen tubing lines must not be contaminated with foreign matter in any form. Hydrocarbon substances, such as oil-base lubricants, are particularly hazardous because of their flammability in an oxygen environment.

42. Oxygen Tube Assembly Repair. Oxygen line tube assemblies, requiring repair other than minor external surface damage, shall be removed from the aircraft or equipment and replaced by a tube assembly which has been cleaned in accordance with the procedures of WP009 00. If a replacement for the defective assembly is not available, the assembly shall be removed and repaired, and then cleaned in accordance with WP009 00 prior to reinstallation. Repair of minor damage requiring buffing or burnishing of the exterior surface of the tubing is permitted in the aircraft or equipment.

NOTE

If removal of the defective assembly is not possible and repair in the aircraft is required, refer to applicable Maintenance Instruction Manual (MIM) for repair and cleaning procedures.

43. Reusing Fittings in Oxygen Systems. When repairing an oxygen system it is permissible to reuse the old fittings after minor rework restores them to acceptable condition. After any necessary rework and prior to reinstallation, the fittings shall be cleaned. The requirements for cleaning of tubing for use in oxygen systems applies to oxygen system fittings (refer to WP009 00).

44. REPLACING TUBE ASSEMBLIES.

45. When replacing a damaged tube assembly, refer to WP008 00 for aluminum and corrosive resistant steel substitutes. Tube assemblies should be formed prior to installation. If the tubing is small and of soft material, the assembly may be formed by hand-bending during installation.

CAUTION

Do not use 5020-0 aluminum alloy tubing with flareless fittings. Use 6061-T6 tubing to replace 5052-0 tubing.

All tubing for replacement in low-pressure oxygen systems shall be aluminum alloy conforming to WW-T-700/4.

Do not attempt to form a tube assembly by pulling it into alignment by use of the coupling nut.

46. USING DAMAGED TUBE ASSEMBLY TO FABRICATE TEMPLATE. If the tubing is of such material and size that hand-bending is impractical, the damaged assembly shall be removed intact. The removed tube assembly may then be used as a forming template when fabricating tube replace-ment. A template will allow length, bends, and angles to be more accurately duplicated. If new routing is required, a new template shall be fabricated as follows:

a. Position material selected for use as a template into one of the fittings to which the replacement assembly will be connected.

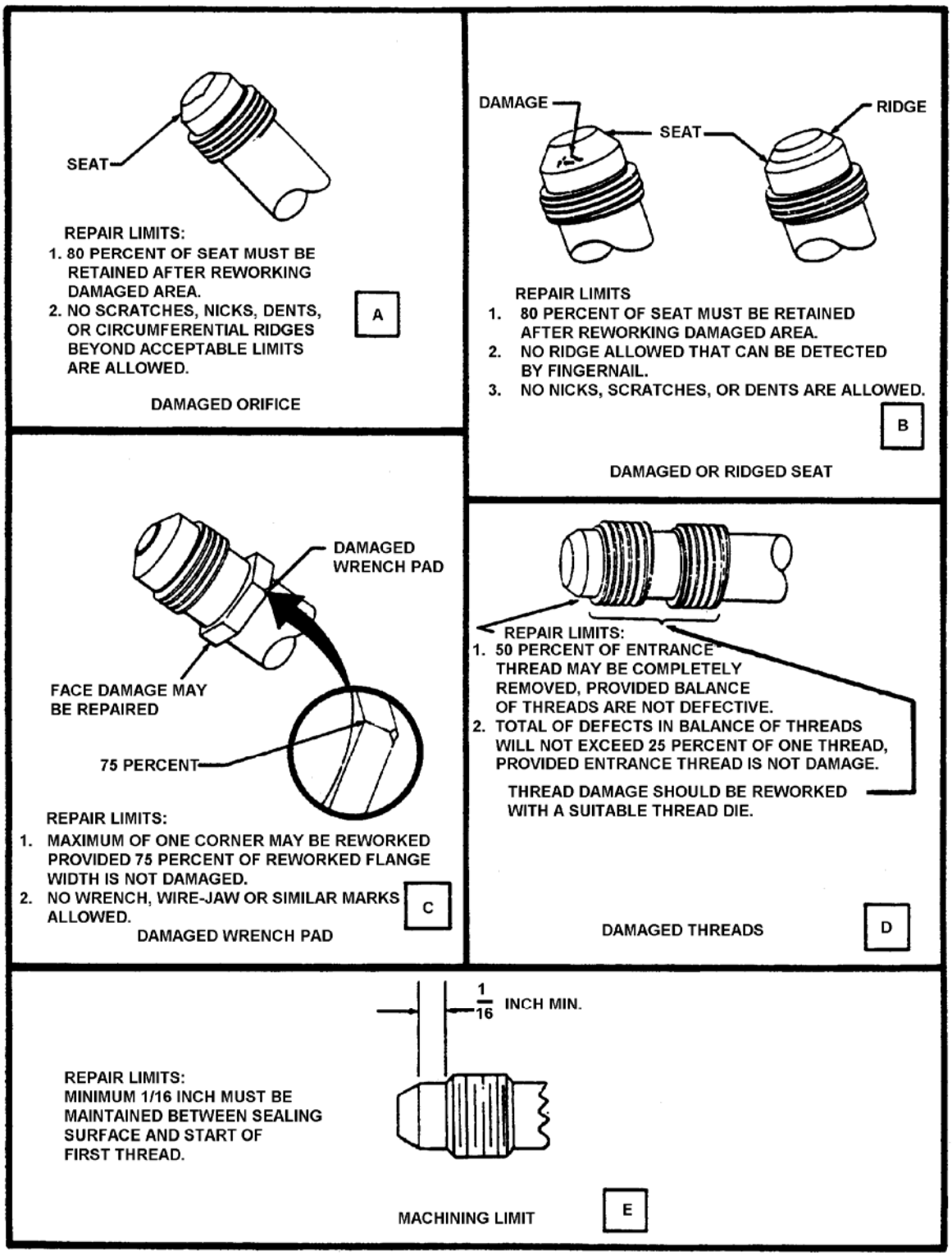
b. Form required bends in template.

c. Remove template and use pattern to bend new tubing.

d. Select path with least total degrees of bend to reduce flow loss and simplify bending.

e. Use path with all bends in same plane when possible.

f. Select path which provides for brackets or clamps to be used as supports at intervals not greater than those given in Table 6.



010014

Figure 14. Reworking Damaged Fittings

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

MAINTENANCE

TUBE ASSEMBLIES

AIR FORCE USE ONLY

Reference Material

Tube Assemblies, Maintenance WP010 00
Tube Assemblies, Fabrication WP009 00
Tube, Aluminum Alloy, Drawn, Seamless WW-T-700/4

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Record of Applicable Technical Directives

None

1. GENERAL.

2. This Work Package applies to Air Force only.

3. REPAIR AND REPLACEMENT OF TUBING ASSEMBLIES

4. **REPAIR AND REPLACEMENT OF DAMAGED TUBING ASSEMBLIES.** Damaged tubing assemblies should be replaced with new assemblies. However, repair may be necessary due to unavailability of parts. Small scratches and abrasions or minor forms of corrosion occurring on the exterior of aluminum alloy may be smoothed out with a burnishing tool or aluminum wool (see WP 010 00, paragraph 5) Following rework, the butting assemblies should be thoroughly cleaned of all solvents and other contaminants. This can be accomplished by flushing with anti-icing fluid, Federal Specification TT-1-735, or anhydrous ethyl alcohol) and rinsing with fresh water. Tubing should be dried with a stream of water purged air or by heating at a temperature of 121°C (250°F) to 149°C (300°F) for a suitable period. After cleaning, all tubing should be treated for corrosion protection per instructions in NAVAIR 01-1A-509 Series.

5. **REPAIR OF LOW-PRESSURE TUBING ASSEMBLIES**. (See Figure 1 and Figure 2) To repair low-pressure lines proceed as follows:

a. Remove damaged portion of tube, de-burr remaining ends, and remove cuttings from tube interior.

b. If possible, bead remaining tube ends.

c. Cut a repair section of same diameter as damaged tubing 1/2-inch shorter than removed damaged portion. De-burr repair section and bead. Clean tube.

d. Cut two synthetic hose connection of proper length and install a hose clamp over each end of each hose connection. Slip both hose connections well back over original tube.

e. Position repair insert.

NOTE

When positioning hose clamps or tightening screws, care should be taken to prevent the screws from chafing or damaging adjacent parts. Where such damage is possible, the hose clamps should be re-positioned on the hose.

f. Slip hose connection midway over junction formed by original tube and repair section. Use glycerin on metal pipe to aid sliding of rubber hose.

g. Tighten hose clamps. (Refer to paragraph 6)

6. To ensure proper sealing of hose connections and to prevent breakage of hose clamps, damage to hose clamps, and damage to hose, instructions on tightening hose clamps should be followed carefully. When available, the approved hose clamp torque wrench shown in Figure 3 should be used. In the absence of a hose clamp torque wrench, the finger-tight-plus-turns method shown in Table 1 should be used. Due to the variance in hose clamp design and hose structure, the values given in the table are approximate and care should be exercised when tightening clamps by this method. Hose clamps installed on self-sealing hose should be tightened using 25 inch-pounds minimum to 30 inch-pounds, maximum torque for original installation and maintain at the same torque value. When sealing is not effective at 30 inch-pounds, the component parts of the connection should be examined and the unserviceable parts replaced. Under no circumstances should the hose clamp be tightened in excess of 30 inch-pounds in an attempt to affect sealing. This added torque will reduce the safety factor of the hose clamp as well as destroy the hose and connection.

7. Hose clamps installed on non-self-sealing hose should be installed and maintained at 25 inch-pounds minimum to 30 inch-pounds maximum torque. If satisfactory sealing is not accomplished at 30 inch-pounds torque, the component parts of the connection should be examined and the unserviceable parts replaced.

8. Hose clamps installed on rubber nipple type fuel cell fittings and fuel system molded rubber connections should be tightened to 15 inch-pounds torque for original installation and maintained at finger-tight plus 1-1/4 turn. Fuel cell fittings are very easily damaged by hose clamps therefore, these torque values should be followed.

9. As an alternate method, hose clamps may be tightened with a special hose clamp tool easily fabricated form a long-type midget socket. (See Figure 4) A slot is cut through the hex end of the socket wide enough and deep enough to accommodate the thumbscrew portion of the hose clamp. This type of tool may be used on the end of a ratchet or extension.

NOTE

Aircraft hose constructed with synthetic compound has a tendency to "cold-flow," therefore, when new hose is installed the clamps should, after a period of time, be retightened in order to obtain the original torque value. This is caused by the synthetic rubber flowing from under the clamping area and not from loosening of the clamps.

10. **REPAIR OF HIGH-PRESSURE TUBING ASSEMBLIES**. (See Figure 5) The damaged portion of the tubing is cut out and removed. The ends of the remaining tubing are cleaned and the rough edges removed. If the damaged section of tubing does not exceed the length of a union, a new section is not needed.

11. **LAYOUT FOR REPLACING TUBING ASSEMBLIES.** If a tubing assembly is to be replaced, the fittings can usually be salvaged and replacing the assembly amounts to the replacement of tubing only. If the tubing is small and made of soft material, the assembly may be formed during installation by hand bending. However, if the tubing is of such material and size that hand bending is impractical, care should be taken to remove the assembly without further damage or distortion so that it can be used as a forming template. This will allow duplication as to length, bends, and angles. All tubing for replacement in low-pressure oxygen systems should be made of aluminum alloy, conforming to Federal Specification WW-T-700/4.

12. **TUBING ASSEMBLY SIZE AND LENGTH.** When replacing a damaged tubing assembly, the same size and material should be selected. Where like materials are not available, wall thickness which can be used for various diameters and tubing materials under the applicable system pressure can be seen in Table 2. A piece of tubing approximately 10 percent longer than the length of tubing to be replaced should be cut. After the required bends have been made, the new tubing may be ½ to 2 inches longer than the old tubing. Allowances should be made for the flaring operation. The amount of tubing in excess of the amount required to flare the tube should be cut off.

NOTE

After cutting, bending, and flaring operations, oxygen tubing assemblies should be cleaned in accordance with Work Package 009 00.

Table 1: Hose Clamp Tightening, Finger-Tight-Plus-Turns Method

Initial Installation Only	Clamp, Worm Screw Type (10 Threads Per Inch)	Clamps, Radial and Other Type (28 Threads Per Inch)
Self-sealing hose - Approximately 25 to 30 inch-pounds	Finger-tight plus 2 complete turns	Finger-tight plus 2-1/2 complete turns
All other aircraft hose - Approximately 25 to 30 inch-pounds	Finger-tight plus 1 - 1/2 complete turns	Finger-tight plus 2 complete turns
If clamps do not seal at specified tightening, examine hose connections and replace parts as necessary.		
The above is for initial installation and should not be used for loose clamps. For retightening loose hose clamps in service proceed as follows: 1. Nonself-sealing hose - If the clamp screw cannot be tightened with the fingers, do not disturb unless leakage is evident. If leakage is present, tighten 1/4 turn. 2. Self-sealing hose - If looser than finger-tight, tighten to finger-tight and add 1/4 turn.		

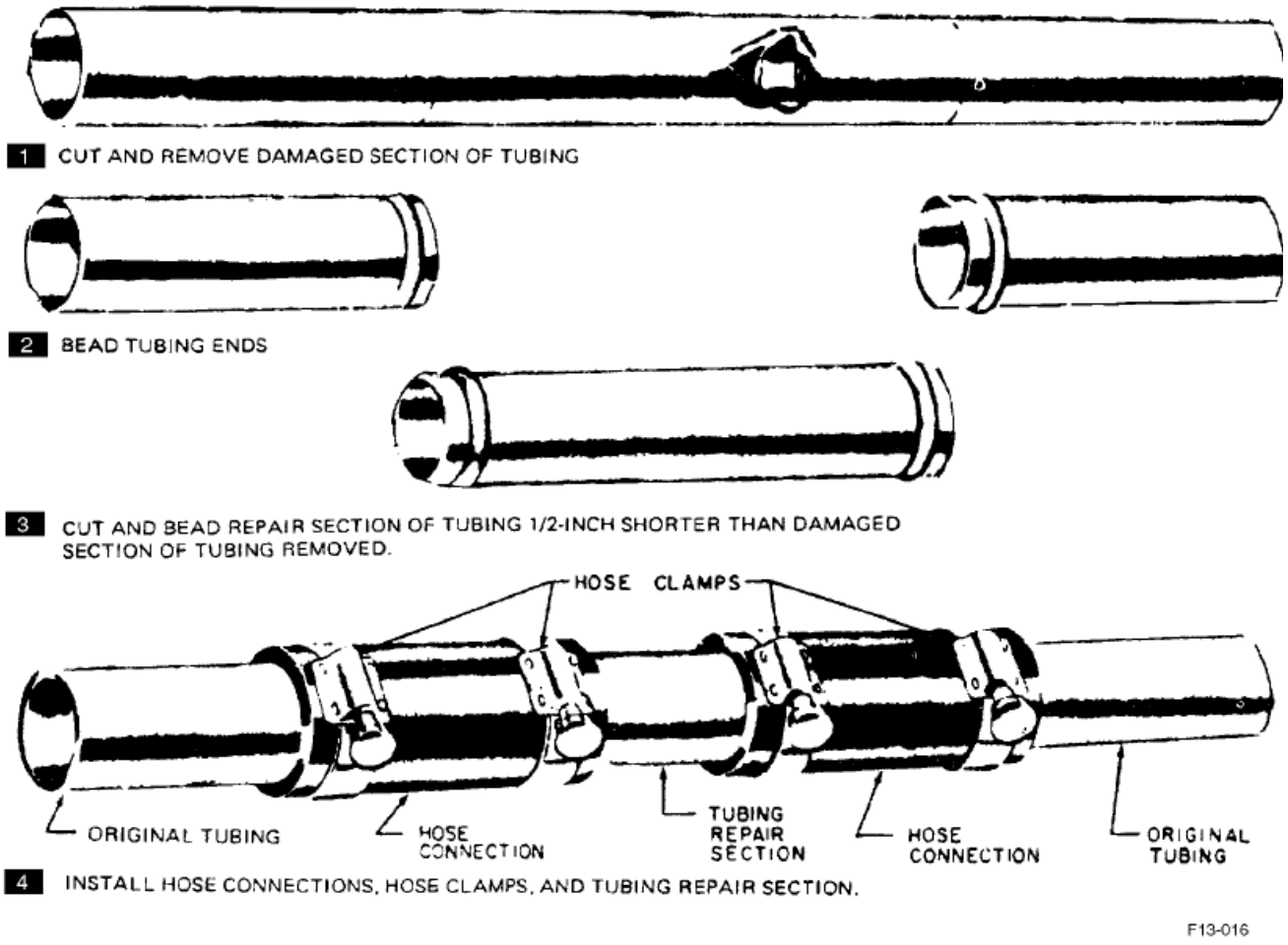
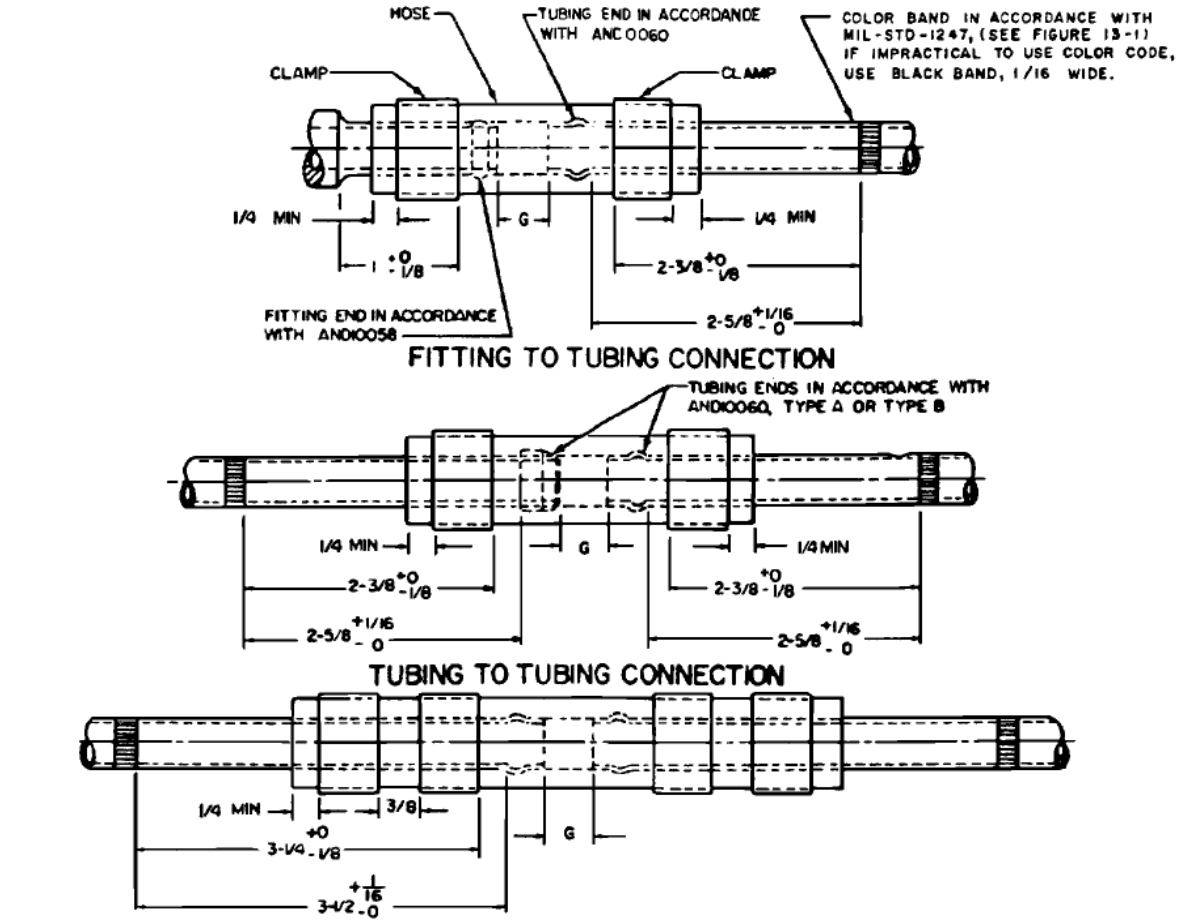


Figure 1: Repairing Low Pressure Tubing



AID FOR DETERMINING HOSE LENGTH				
CONNECTION	HOSE OVER FITTING	GAP G	HOSE OVER TUBING (ONE END)	TOTAL HOSE LENGTH
FITTING TO TUBING CONNECTION	1-3/8	ACTUAL GAP	1-1/2	2-7/8 + GAP
TUBING TO TUBING CONNECTION		ACTUAL GAP	1-1/2	3 + GAP
TUBING TO TUBING CONNECTION USING DOUBLE HOSE CLAMPS		ACTUAL GAP	2-1/2 APPROX	5 + GAP

DIMENSIONS IN INCHES

F13-017

Figure 2: Tubing End Clearance for Low-Pressure Tubing Repair

Table 2: Determining Tube Thickness and Burst Pressure

Outside Diameter	Tube Thickness												
	.012	.016	.020	.028	.035	.042	.049	.058	.065	.083	.095	.109	.120
1/8	c, d 1920	c, d 2560	c, d 3200	a, c, d 4480	a, c, d 5600	6720	7840						
3/16		c, d 1707	c, d 2133	a, c, d 2987	a, b, c, d, e, f 3733	b 4480	b, c, d 5227	6187	6933	8853			
1/4	c, d 960	c, d 1280	c, d 1600	a, b, c, d, e, f 2240	a, b, c, d, e, f 2800	e, f 3360	b, c, d, e, f 3920	b 4640	5200	6640	7600	8720	
5/16	c, d 768	c, d 1024	c, d 1280	b, c, d 1792	a, b, c, d, e, f 2240	a 2688	b, c, d, e, f 3136	b, c, d, e, f 3712	b, c, d 4160	b 5312	b 6080	6976	7680
3/8	640	854	c, d 1067	a, b, c, d, e, f 1493	a, b, c, d, e, f 1867	a, b 2240	a, b, c, d, e, f 2613	b, c, d 3093	b, c, d, e 3466	b, c, d 4427	b 5067	b 5813	6400
1/2	480	640	c, d 800	a, b, c, d, f 1120	a, b, c, d, e, f 1400	a 1680	a, b, c, d, f 1960	a, b, c, d, f 2320	a, b, c, d, e, f 2600	b, c, d 3320	b 3800	b, c, d 4360	4800
5/8	384	512	c, d 640	a, b, c, d, e, f 896	a, b, c, d, e, f 1120	a 1344	a, b, c, d, e, f 1568	b, c, d 1856	a, b, c, d, e, f 2080	b 2656	b, c, d 3040	3488	c, d 3840
3/4		427	c, d 533	b, c, d 747	b, c, d, e, f 933	b 1120	b, c, d, f 1307	b, c, d, e, f 1547	b, c, d, e, f 1733	b, c, d, e, f 2213	2533	2907	b, c, d 3200
1		320	400	a, c, d, e, f 560	a, b, c, d, e, f 700	840	a, b, c, d, e, f 980	b, e, f 1160	a, b, c, d, f 1300	b, c, d, f 1660	b 1900	2180	c, d 2400
1-1/8		284	356	498	b, c, d, e, f 622	747	b, c, d, e, f 871	b, c 1031	b, c, d 1156	b 1476	1689	1938	b, c, d, e 2133
1-1/4					a, b, c, d, e, f		a, b, c, d, e, f	b, e	b, c, d, e, f	b, c, d			b, c, d

Table 2: Determining Tube Thickness and Burst Pressure (Continued)

Outside Diameter	Tube Thickness												
	.012	.016	.020	.028	.035	.042	.049	.058	.065	.083	.095	.109	.120
		256	320	448	560	672	784	928	1040	1328	1520	1744	1920
1-3/8					c, d, e, f		b, c, d, f	b, c, d, f	b	b, c, d, f			
		233	291	407	509	611	713	844	945	1207	1382	1585	1745
1-1/2				a	b, c, d, f	c, d	a, b, c, d, f	b, c, d, f	a, b, c, d, e, f	b	b, c, d, f		
		213	267	373	467	560	653	773	867	1107	1267	1453	1600
2					a, b, c, d, e, f		a, b, c, d, e, f	b	a, b, c, d, e, f	b	b, c, d		b
		160	200	280	350	420	490	580	650	830	950	1090	1200

Explanation of Code

Code Figures	Material	Tubing Specification
a	Aluminum 5052	Federal Specification WW-T-700/4b
b	Aluminum 2024T	Federal Specification WW-T-700/3b
c	Stainless Steel Annealed	Military Specification MIL-T-8504
d	Stainless Steel 1/8 Hard	Military Specification MIL-T-6845
e	Aluminum 6061	Military Specification MIL-T-7081
f	Aluminum 6062	Federal Specification W-T-700/6b

Example:
Code letters a, b, c, d, e, and f indicate that the particular tube diameter and wall thickness are standard for the tubing listed.

The table is based on a tube wall stress of 10,000 PSI and the formula is as follows. $P=\frac{2ft}{D}$

P = Internal fluid pressure PSI.
f = Tube wall stress PSI.
t = Hall thickness of tubing in inches.
D = Outside diameter of tubing in inches.
Per Military Specification MIL-H-5440, the following minimum tube burst pressures are required for the noted system pressures. (The required factor of safety is 4.)

System Pressure PSI

Burst Pressure PSI

Table 2: Determining Tube Thickness and Burst Pressure (Continued)

1000	4000
1500	6000
3000	12,000

To determine the tube minimum wall thickness when the tube burst pressure and the outside diameter are known, proceed as follows:
The tubing wall thickness may be determined for the tubing outside diameter used, such that the conversion factor is not less than that calculated.

Correct Use of Table				
Material	**Ultimate Strength PSI**	**System Pressure PSI**	**Burst Pressure PSI**	**Conversion Factor of Chart Burst Pressure Ultimate Strength - 10,000**
Aluminum 5052-0	29,000	1,000	4,000	4,000 ÷ 2.9 = 1,380
		1,500	6,000	6,000 ÷ 2.9 = 2070
		3,000	12,000	12,000 ÷ 2.9 = 4,150
Aluminum 2024-T	64,000	1,000	4,000	4,000 ÷ 6.4 = 625
		1,500	6,000	6,000 ÷ 6.4 = 938
		3,000	12,000	12,000 ÷ 6.4 = 1,875
Aluminum 6061 and 6062 Cond. T4	30,000	1,000	4,000	4,000 ÷ 3.0 = 1,333
		1,500	6,000	6,000 ÷ 3.0 = 2,000
		3,000	12,000	12,000 ÷ 3.0 = 4,000
Aluminum 6061 and 6062 Cond. T6	42,000	1,000	4,000	4,000 ÷ 4.2 = 950
		1,500	6,000	6,000 ÷ 4.2 = 1,438
		3,000	12,000	12,000 ÷ 4.2 = 2,857
Stainless Steel Annealed	75,000	1,000	4,000	4,000 ÷ 7.5 = 533
		1,500	6,000	6,000 ÷ 7.5 = 800
		3,000	12,000	12,000 ÷ 7.5 = 1,600
Stainless Steel Cond. 1/8 Hard	105,000	1,000	4,000	4,000 ÷ 10.5 = 380
		1,500	6,000	6,000 ÷ 10.5 = 571
		3,000	12,000	12,000 ÷ 10.5 = 1,142

Standard wall thicknesses may be obtained from the table, such that the factor is not less than the calculated value.
Example:

Table 2: Determining Tube Thickness and Burst Pressure (Continued)

It is required to determine the minimum standard wall size for a 1/2-inch OD 1/8 hard stainless steel tube for a 3000 lb. system. From the CORRECT USE OF TABLE the conversion factor for this tube is 1142. Now determine the nearest value above 1142. This gives a 1/2-inch X 0.035 tube which is a standard size indicated by the code d for 1/8 hard stainless steel.

Taking any value from the table, it is easy to determine the burst pressure of the tube represented by multiplying by the ratio of the maximum tensile strength to 10,000.

Example:

The value of 1400 for a 1/2-inch outside diameter X 0.035 tube is the fluid pressure equivalent to 10,000 PSI stress in the wall. For a 1/8 hard stainless steel, the wall could be stressed to 105,000 PSI tensile strength or 10.5 times 1400 equals 14.700 an amount well over 12,000 the burst pressure for a 3000 lb. system.

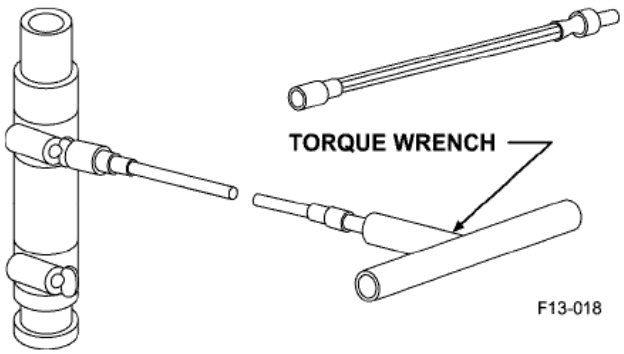


Figure 3: Torque Wrench and Extension

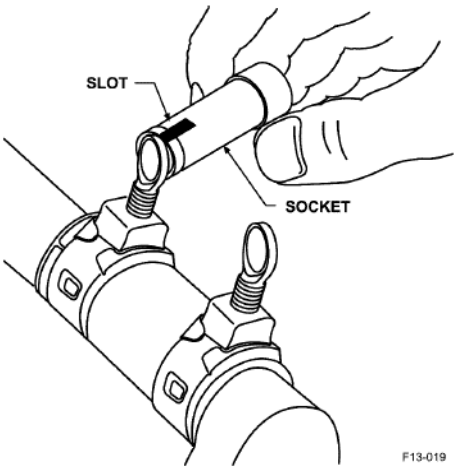


Figure 4: Tightening Hose Clamp with Socket

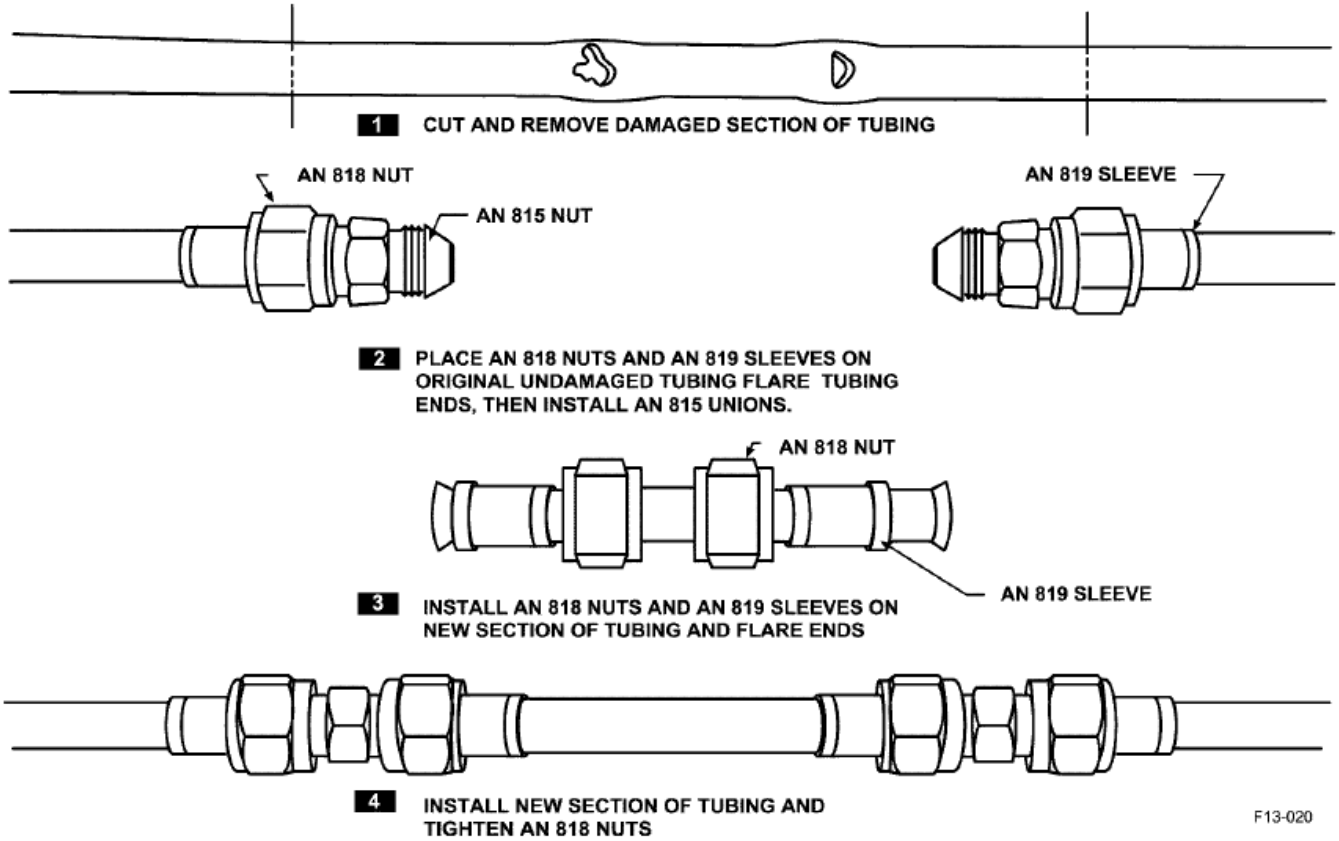


Figure 5: Repairing High Pressure Tubing

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION AND MAINTENANCE

PERMASWAGE® FITTINGS

Reference Material

None

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Record of Applicable Technical Directives

None

1. GENERAL.

2. This work package contains instructions for using the DLT Permaswage Tube Connecting System. It explains how to use DLT series swage tool kits to swage DMC Permaswage fittings. This manual applies to fittings rated up to 3,000 psi (Table 1). Basic maintenance instructions for the tool kits are also included. Older D10000 and D12000 Series Permaswage Tool Kits are obsolete and are no longer approved for use.

CAUTION

The equipment in this system is subjected to extremely high pressures during swaging. Improper use may result in tool failure or personal injury. The equipment described in this manual should be used only by qualified personnel.

3. Tube assembly repair using Permaswage fittings and technique is considered a permanent repair. However, the Permaswage technique is only applicable to tubing assemblies not exceeding the material, line size, and operating pressure requirements of Table 2.

CAUTION

Do not use annealed CRES or aluminum tubing 5052 for repair.

Ensure paint and/or other contamination has been cleaned/removed prior to Permaswage installation, see step 13b.

4. SUMMARY OF OPERATION

5. The operation starts by preparing the tube. The tube to be connected is cut, then deburred. The installation depth is properly marked and the chosen fitting is placed on the tube. Next, the swage tool is placed so it surrounds the fitting. The swage tool is then activated by pressure from a pump. This causes the swage tool to radially compress the fitting and tube. Enough pressure is applied to swage the fitting onto the tube. The swaged connection is then inspected.

6. PREPARATION FOR SWAGING

7. Check Sizes and Materials. Check material compatibility between tubing and fittings. (See Table 2)

a. Check for satisfactory thickness of tube walls, based on tube OD, material, and system/line operating pressure. (See Table 2)

b. Select fitting size, based on tube OD.

c. Select tool kit, based on tube OD and system/line pressure.(Table 3)

8. Examine Tube Condition Prior to Installation. The tube should be clean from any paint or other foreign material (Swaging is permitted on Alodine finish).

a. There should not be any flat spots, scratches and/ or nicks on the tube.

b. Cleaning operation on the O.D. of the tube must take place prior to installation. Lightly clean the tube with a rag or Scotch Bright, provided that in all cases the area of the swage remain within the tube tolerance.

9. Cut Tube (If Needed)

NOTE

A minimum length of straight tube (before a bend) is required to produce a satisfactory swaged connection. (See Table 4, Figure 1)

a. Select Cutting tool for appropriate tube size from parts listed in Table 5. Mark cutting point on tube. Retract cutting wheel of tube cutter by turning drive screw counter-clockwise. Use screwdriver or Allen wrench. See Figure 2.

b. Open cutter head by rotating tube cutting assembly inside cutter handle.

c. Slide tube cutter over tube.

d. Extend cutting wheel of tube cutter by turning drive screw clockwise until cutting wheel touches tube. Further extend cutting wheel by turning drive screw in tube cutter (approximately 1/6 turn clockwise).

e. Rotate tube cutter handle around tube until there is a noticeable ease of rotation.

f. Further extend cutting wheel by turning drive screw in tube cutter 1/20 to 1/10 turn clockwise.

g. Repeat steps 9.e. and 9.f. until tube has been cut.

CAUTION

Do not overturn the cutting wheel in order not to deform the tube.

Table 1: Typical Styles and Part Number Breakdown of Permaswage Fittings

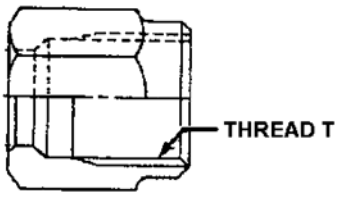
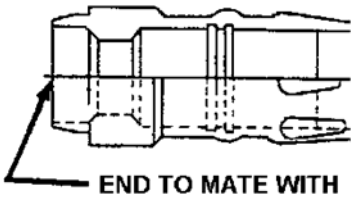
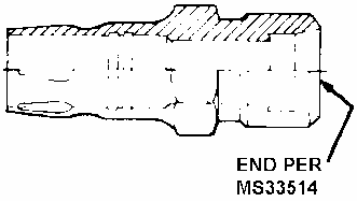
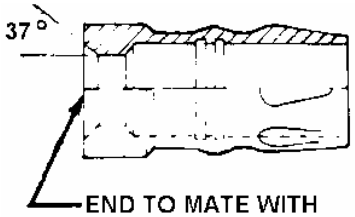
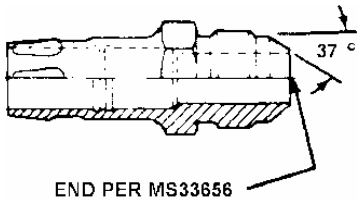
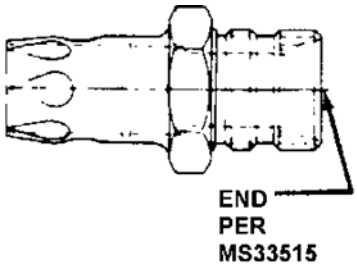
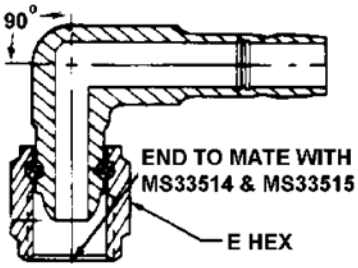
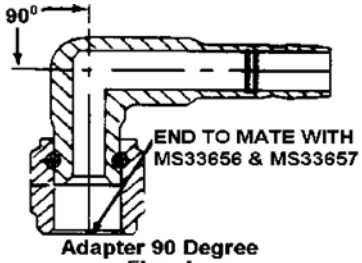
D10006- Nut  **Flared and Flareless Nut**	D10007- Sleeve  **Sleeve Flareless**	D10008- Union  Union, Flareless
D10010- Sleeve  **Sleeve, Flared - Female**	D10011- Union  Union, Flared - Male	D10019- Union  **Union to Flareless Bulkhead**
D10021- Adapter 90º  **Adapter 90 Degree Flareless**	D10027- Adapter 90º  **Adapter 90 Degree Flared**	D10036- Standard Union  **Union**

Table 1: Typical Styles and Part Number Breakdown of Permaswage Fittings (cont)

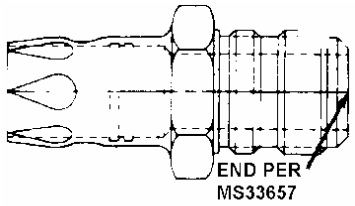
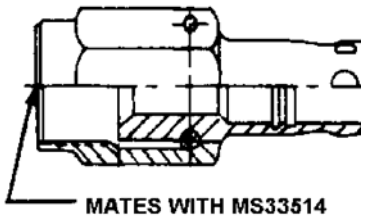
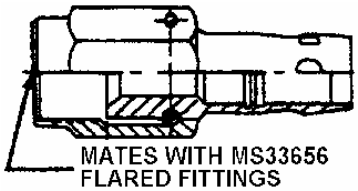
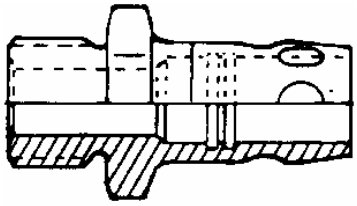
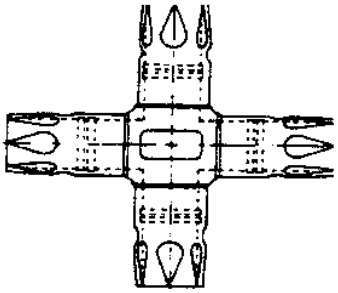
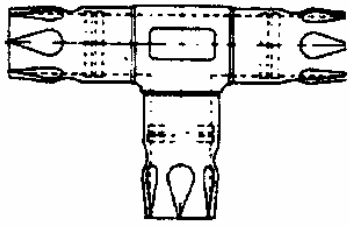
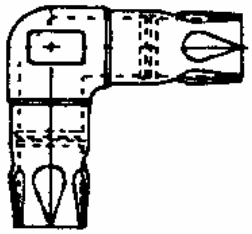
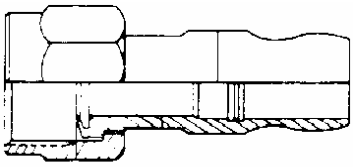
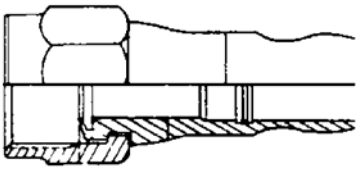
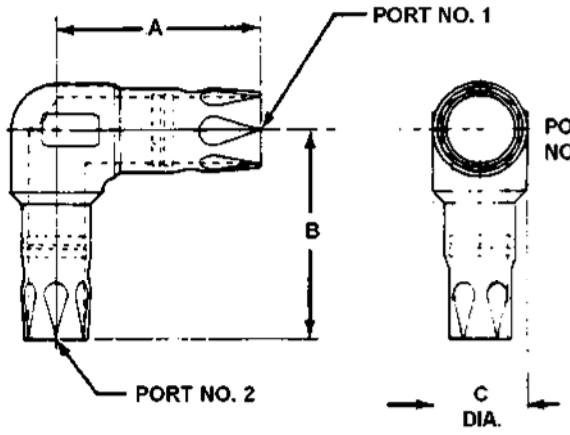
D10046- Union  Union to Flared Bulkhead	D10059- Sleeve  **Separable Flareless Sleeve Assembly**	D10060- Sleeve  **Separable Flared Sleeve Assembly**
D11007- Adapter  **Male Adapter - Lipseal**	D9854- Cross  Cross	D9855- Tee  **Tee**
D9856- Elbow  Elbow	DD00200AP- Adapter  Female Adapter, Lipseal Assembly	DD00300AP- Reducer  **Reducer, Female Adapter Lipseal Assembly**

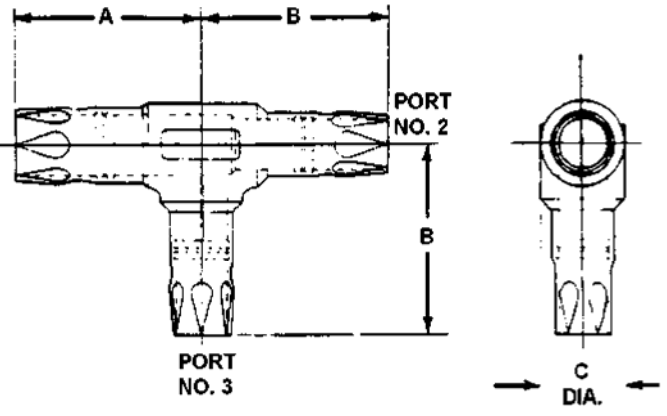
Table 1: Typical Styles and Part Number Breakdown of Permaswage Fittings (cont)

Elbow Reducer D10036-(1)-(2)	Tee Reducer D10023-(1)-(2)-(3)



D10035 ELBOW 90 DEGREE REDUCER

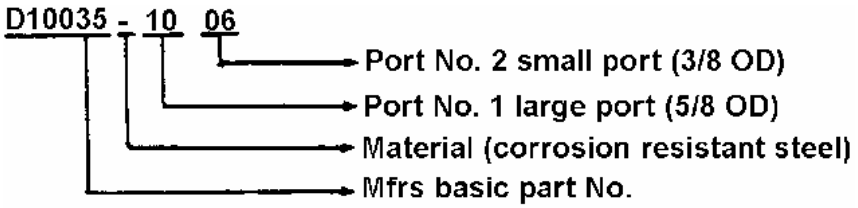
A DIMENSION FORGING SIZE	"B" DIMENSION FOR PORTS 2 AND 3	C DIAMETER
3	.390/.375	1.050
4		
5	.465/.450	1.120
6		
8	.550/.530	1.190
10		
12	.705/.690	1.755
16		
20	.866/.846	1.860
	1.041/1.021	1.990
	1.385/1.365	2.344
	1.697/1.677	2.468
	1.885/1.865	2.593



D10023 TEE REDUCER

A DIMENSION FORGING SIZE	"B" DIMENSION FOR PORTS 2 AND 3	C DIAMETER
3	.390/.375	1.050
4		
5	.465/.450	1.120
6		
8	.550/.530	1.190
10		
12	.705/.690	1.755
16		
20	.866/.846	1.860
	1.041/1.021	1.990
	1.385/1.365	2.344
	1.697/1.677	2.468
	1.885/1.865	2.593

End size for 90 degree elbow is specified as follows:



End size for tee reducer is specified as follows:

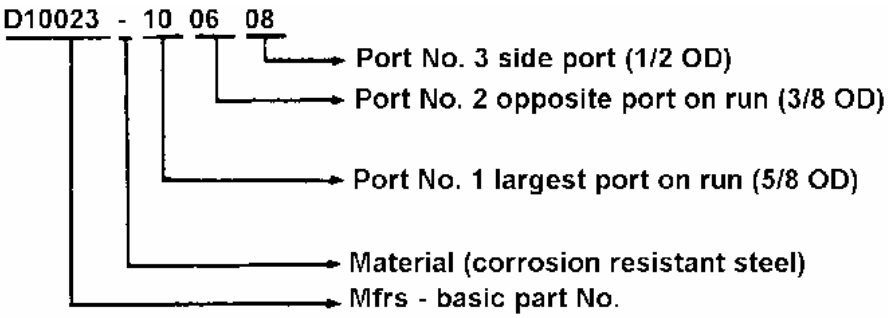
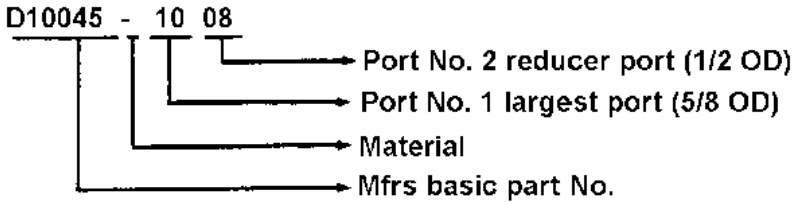


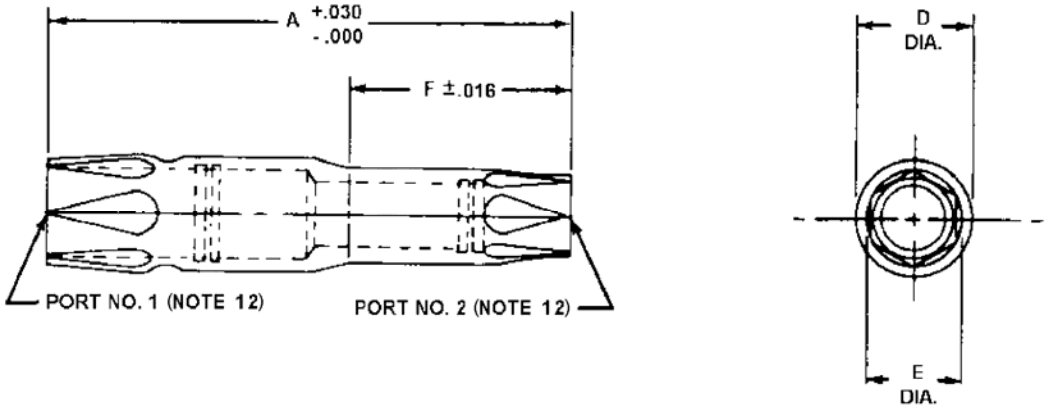
Table 1: Typical Styles and Part Number Breakdown of Permaswage Fittings (cont)

Reducer D10045-(1)-(2)

End size for straight reducer is specified as follows:



UNION TO FLARED BULKHEAD



A (OVERALL LENGTH)										"D" DIA. (REF.)		"E" DIA. (REF.)
.275	.338	.413	.480	.655	.787	.929	1.257	1.489	1.786	PORT NO. 1		
	4	5	6	8	10	12	16	20	24			
-	-	-	-	-	-	-	-	-	-	2	PORT NO. 2 (REDUCER PORT)	-
	1.640	1.688	1.790	2.375	2.500	2.570	2.985	-	-	3		.275
		1.765	1.850	2.415	2.550	2.620	3.070	3.425	-	4		.338
			1.875	2.425	2.575	2.630	3.150	3.475	3.710	5		.413
				2.425	2.590	2.640	3.340	3.688	3.915	6		.480
					2.953	3.030	3.420	3.796	3.984	8		.655
						3.030	3.375	3.770	3.955	10		.787
							3.375	3.770	3.955	12		.929
								3.850	4.040	16		1.257
									4.140	20		1.489

F										PORT NO. 1	
3	4	5	6	8	10	12	16	20	24		
-	-	-	-	-	-	-	-	-	-	2	PORT NO. 2 (REDUCER PORT)
	.775	.775	.775	.775	.775	.775	.850	-	-	3	
		.875	.875	.875	.875	.875	.975	.975	-	4	
			.925	.925	.925	.925	1.075	1.075	1.075	5	
				.940	.940	.940	1.240	1.240	1.240	6	
					1.420	1.420	1.420	1.420	1.420	8	
						1.460	1.460	1.460	1.460	10	
							1.520	1.520	1.520	12	
								1.780	1.780	16	
									2.075	20	

Table 2. Recommended Fitting/Tube Material and Wall Thickness Combinations (0-3000 psi)

FITTING MATERIAL	TUBE MATERIAL	MAX. LINE PRESSURE	TUBE OD (inch sizes)									
			3/16	1/4	5/16	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2
			-03	-04	-05	-06	-08	-10	-12	-16	-20	-24
6061-T6 Al (AMS-QQ-A-225)	6061-T6 Al (AMS4083)	1,500 psi	---	.035	.035	.035	.035	---	---	---	---	---
		1,000 psi	.020	.020	.028	.028	.028 .035	.035	.035	.042 .049	---	---
		500 psi	---	---	---	---	---	---	---	.035	.035	---
		200 psi	---	.020	---	.020	.020	.020	.020	.020	---	.035
C.P. Ti (AMS4921)	3AL-2.5V CWSR TI (AMS4944 or AMS4945)	3,000 psi	.016	.016	.016	.019	.026	.032	.039	.051	.063	---
		2,000 psi	---	---	.022	.020 .022	.020 .023	.023 .027	.027 .032	.036	.045	.054
21-6-9 CRES (AMS5656)	6061-T6 Al (AMS4083)	3,000 psi	---	.035	.042	.049	.064	.065	.095	---	---	---
		1,500 psi	---	.035	.035	.035	.035	---	---	.065	.065	---
		1,000 psi	---	.020	---	---	---	.035	.035	---	.065	---
		500 psi	---	.028	.035	.035	.035	.035	.035	.035	.035	.035
	3AL-2.5V CWSR TI (AMS4944 or AMS4945)	3,000 psi	.016	.016	.020	.020 .026	.026	.032	.039	.051	.065	---
	3AL-2.5V ANNEAL TI (AMS4943 or GM3118A)	3,000 psi	---	---	---	.028	.028 .035	.046	.058	.073	---	---
	21-6-9 CRES (AMS5561)	3,000 psi	.016	.016	.016 .020	.020	.026	.032 .033	.039	.052	.054 .063	---
		2,000 psi	---	---	---	---	---	---	---	---	---	.054
		1,500 psi	---	---	---	---	---	---	---	.020	.032	---
		1,000 psi	---	---	---	---	---	---	---	---	.024	---
		500 psi	---	---	---	---	---	---	---	---	.024	---
		350 psi	---	---	---	---	---	---	---	---	---	.035
	304 1/8HD CRES (AMS5566 or AMS5654)	3,000 psi	.016	.020	.020	.028	.035	.042	.058	.065	---	---
		1,500 psi	---	---	---	---	---	---	---	---	.049	.065

10. De-burr Tube. Select de-burring tool stem assembly, based on tube OD. (See Table 6) **(QA)**

a. Insert stem assembly into de-burring tool handle. Turn stem assembly clockwise until finger tight, while depressing plunger. (See Figure 3)

b. Release plunger, and check to see that rubber plug is expanded. Lightly lubricate rubber plug of stem assembly with swage lube.

c. Depress plunger of de-burring tool and insert de-burring tool into end of tube. Release plunger.

d. Hold tube, and rotate knurled handle of de-burring tool clockwise while applying slight pressure towards tube. Continue to rotate until end of tube is de-burred.

e. WITHOUT DEPRESSING PLUNGER, withdraw de-burring tool from tube until first ridge of rubber plug is exposed. Wipe ridge clean. Check end of tube for satisfactory de-burring. (Leave de-burring tool in tube until step 12.)

f. If tube is not satisfactorily de-burred, push tool back into tube and repeat steps 10.d. and 10.e.

11. Wipe outside of tube clean.

12. Remove de-burring tool from tube. Depress plunger of de-burring tool and unscrew stem from handle. Wipe stem clean, lightly lubricate and store.

13. Mark Insertion Depth on Tube. Ensure paint and/or contamination has been cleaned/removed prior to Permaswage installation.

NOTE

If the insertion marking tool is not available, mark the insertion depth per the dimensions (See Table 7).

a. Mark tube as indicated by insertion marking tool. (See Figure 4) Use marking pen supplied in tool kit, or any other suitable marking method. Mark tube in at least two places, 180 degrees apart. **(QA)**

Do not use marking pens containing chloride or graphite on titanium tubing, as either chemical can damage titanium.

NOTE

Be sure to use correct slot in marking guide and mark tube the entire length of slot in marking guide.

b. Ensure to clean paint and/or contamination from tube end prior to Permaswage installation by the following procedure: **(QA)**

(1) If paint is present on tube, mark tube as is on the painted surface per step 13a.

(2) Clean paint off just to the mark and obliterate the mark, taking care to not extend the cleaned area beyond the mark.

(3) Remark the cleaned surface (step 13a) and proceed with Permaswage process.

14. Slide fitting onto tube.

15. <u>OPERATING INSTRUCTIONS FOR SWAGE TOOLING</u>

This tooling is subject to extremely high pressure during swaging. Improper use may result in tool failure or personal injury. This tooling should only be used by qualified personnel.

16. DLT Pre-swage Inspection Procedure

a. Inspect the tube ends to be swaged for burrs on the outer diameter and the inner diameter. If not deburred properly, it will cut the silicone seal and scratch the I.D. of the fittings. **(QA)**

b. Check the swage dies for size and to ensure they are free of foreign material between slots. The two halves must be a matched set.

c. Check the power unit model number and head assembly part number.

d. Check to ensure the head and the dieblock are positioned correctly with respect to the dies and the fitting.

e. Check the insertion mark using the proper DMC marking tool for the tube size. **(QA)**

f. Ensure proper insertion of the fitting. Part of the insertion mark must be visible when the fitting is in place. **(QA)**

g. Ensure that the stop endplate on the head assembly is not pushed by the fitting. The fitting must just touch the stop endplate prior to the swaging. **(QA)**

h. Verify that the material, size and wall thickness of the tube are as specified.

i. Ensure correct fitting part number and size.

j. Verify that the pump develops 10,000 ± 250 psi hydraulic pressure. If using a pneumatic pump the pump inlet air pressure should be 80 - 120 psi.

k. Ensure that the two ends of the tubes being connected, or a tube end being connected to a separable joint, are aligned within a reasonable amount. No more than finger pressure must be applied to align the two tube ends.

l. When B-nuts are involved tighten the B-nuts first, and then perform the swage is the preferred sequence.

17. Preparation of Tooling

a. Select proper power unit and head assembly based on tube OD. (See Tables 8 and 9).

b. Push lower die/holder assembly out of head assembly.

c. Make sure upper and lower halves of die have same serial number.

d. Join lower die/holder assembly to top of power unit. (See Figure 5) (Note that this assembly will fit on power unit only one way.)

e. Connect one end of hydraulic hose to portable hydraulic pump. Make sure pump delivers 10,000 ± 250 psi. Connect other end of hydraulic hose to power unit.

18. Position fitting on tube Position the fitting on the tube so that part of the tube insertion mark is covered by the fitting. Make sure part of the tube insertion mark is also outside the fitting. **(QA)**

19. Position swage tool

a. Slide head assembly over fitting and tube. Ensure beveled end of die is towards center of fitting.

b. Slide head assembly into power unit. Head assembly will fit on power unit only one way; position knurled strip on head assembly on same side as knurled strip on power unit. (See Figure 5)

c. Move the power unit toward the center of the fitting, until the fitting hits the end plate stop.

20. Swage Connection Apply hydraulic pressure (10,000± 250 psi) to the swage tool. Keep the power unit, fitting, and tube in the positions described in steps 18. and 19.c.

21. Remove Tooling

a. Release the pressure to allow the dies to open. After the die halves have opened, slide the head assembly out of the power unit. The two parts do not require much pressure to separate.

b. Remove the head assembly from the swaged fitting/tube.

22. INSPECTION OF SWAGED CONNECTION

23. Select inspection gage, based on size of fitting. (See Table 10)

NOTE

Inspect swaged fittings only with inspection gages supplied by Designed Metal Components--use no other method. To verify dimensions of inspection gauges, see Table 10.

a. Swage fittings must be inspected after swaging. This action verifies the fitting has been compressed accurately. **(QA)**

b. Place inspection gage over swaged end of fitting. Ensure internal shoulder of gauge contacts end of fitting. (See Figure 6 and 7) **(QA)**

c. Outside diameter of fitting must be smaller than ID of gauge. Part of the die marks on fitting must be visible outside of gauge. **(QA)**

d. Rotate gauge 90°, and repeat step 23.c. above. **(QA)**

NOTE

If inspection gauge does not fit properly over the swaged fitting, reswage the fitting. If dimensions of swaged fitting are still not satisfactory, contact your Designed Metal Components representative for assistance.

Table 3: DLT Tool Kits

TUBE SIZE** (O.D.)	TOOL KIT	
	PERMASWAGE® NUMBER	NATIONAL STOCK NUMBER
Single Size Tube Mini Kits: Contains basic hardware for fitting installation, does not include pump		
-03	DLT05PSKT3001	(NOT YET ASSIGNED)
-04	DLT05PSKT3000	5180-01-321-7878
-05	DLT10PSKT3001	(NOT YET ASSIGNED)
-06	DLT10PSKT3000	5180-01-321-7879
-08	DLT20PSKT3002	(NOT YET ASSIGNED)
-10	DLT20PSKT3004	(NOT YET ASSIGNED)
-12	DLT30PSKT3000	5180-01-321-7881
-16	DLT40PSKT3002	5180-01-455-5056
-20	DLT40PSKT3003	(NOT YET ASSIGNED)
-24	DLT40PSKT3004	(NOT YET ASSIGNED)
Multiple Size Tube Kits: Contains basic hardware for fitting installation, does not include pump		
-04, -05, -06, -08, -10	DLT30MAPSKT3000	(NOT YET ASSIGNED)
-04, -06, -08, -10, -12	DLT30MAPSKT3001	(NOT YET ASSIGNED)
-04, -05, -06, -08, -10, -12	DLT30MAPSKT3002	(NOT YET ASSIGNED)
-03, -04, -05, -06, -08, -10, -12	DLT30MAPSKT3004	(NOT YET ASSIGNED)
-03, -04, -05, -06	DLT30MAPSKT3011	(NOT YET ASSIGNED)
-04, -05, -06, -08	DLT30MAPSKT3015	(NOT YET ASSIGNED)
-04, -06, -08, -10	DLT30MAPSKT3017	(NOT YET ASSIGNED)
-04, -06, -10, -12	DLT30MAPSKT3018	(NOT YET ASSIGNED)
-04, -06, -08, -10, -12, -16, -20, -24	DLT40MAPSKT3000	5180-01-321-7882
-04, -06, -08, -10, -12, -16, -20	DLT40MAPSKT3001	(NOT YET ASSIGNED)
-04, -05, -06, -08, -10, -12, -16, -20, -24	DLT40MAPSKT3002	(NOT YET ASSIGNED)
-04, -05, -06, -08, -10, -12, -16	DLT40MAPSKT3003	(NOT YET ASSIGNED)
-04, -06, -08, -10, -12, -16	DLT40MAPSKT3004	(NOT YET ASSIGNED)
-03, -04, -05, -06, -08, -10, -12, -16, -20, -24	DLT40MAPSKT3005	(NOT YET ASSIGNED)
-03, -04, -05, -08, -10, -12, -16, -20, -24	DLT40MAPSKT3006	(NOT YET ASSIGNED)
-03, -04, -06, -08, -10, -12, -16	DLT40MAPSKT3007	(NOT YET ASSIGNED)
-10, -12, -16	DLT40MAPSKT3008	(NOT YET ASSIGNED)
-04, -05, -06, -08, -10, -12, -16, -20	DLT40MAPSKT3011	(NOT YET ASSIGNED)
Comprehensive Field Repair Kits: Contains everything for making field repairs, includes hand pump		
-04, -06, -08, -10, -12, -16, -20, -24	DLTFRPSKT3000	5120-01-472-9129
-04, -06, -08, -10, -12	DLTFRPSKT3001	5180-01-341-4030
-04, -06	DLTFRPSKT3003	5180-01-115-7007
-04, -05, -06, -08, -10, -12	DLTFRPSKT3004	5180-01-517-9627
-03, -04, -05, -06, -08, -10, -12	DLTFRPSKT3008	5120-01-374-6290
-03, -04, -05, -06, -08, -10, -12, -16, -20, -24	DLTFRPSKT3009	5180-01-374-8266

** Size represented in 1/16 inch increments.

DLT Tool Kits contain swage tools, marking templates and inspection gages for each size listed. Also included are tube cutters, de-burring tools with stem assemblies, a hex key and a marking pen.

Table 4: Minimum Straight Tube Length Required Before Bend

TUBE OD	"L", MINIMUM STRAIGHT LENGTH
3/16"	.773"
1/4"	.915"
5/16"	.955"
3/8"	.990"
1/2"	1.493"
5/8"	1.533"
3/4"	1.603"
1"	1.748"
1 1/4"	1.850
1 1/2"	1.975"

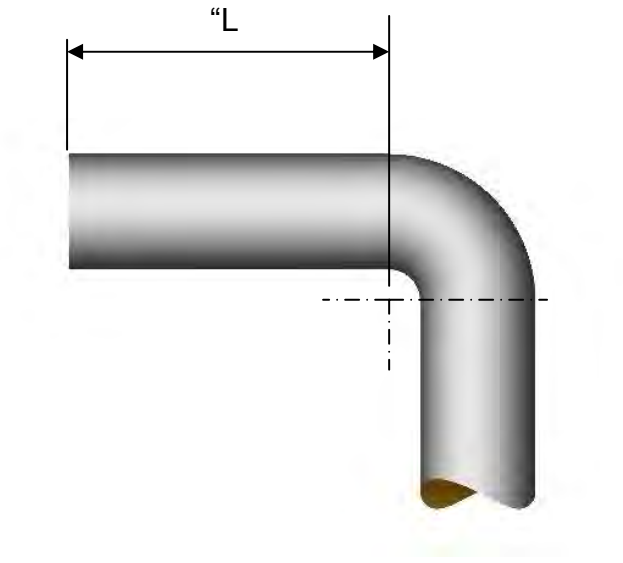


Figure 1: Minimum Straight Length

Table 5: Tube Cutter, spare Cutter Wheel, and Miscellaneous Components

SIZES	TUBE CUTTER PART NUMBER	SPARE CUTTER WHEEL PART NUMBER	MISC. COMPONENTS(1)	PART NUMBER
1/4" through 3/8"	D12530-001	D12530-109	Hex Key	DLT5103-104-01
1/2" through 3/4"	D12531-001	D12531-109	Marking Pen	DLT5301-000-01
7/8" through 1 1/2"	D12532-001	D12532-109	Swage Lube.	DLTSWLUB0001

(1) Applies to all sizes

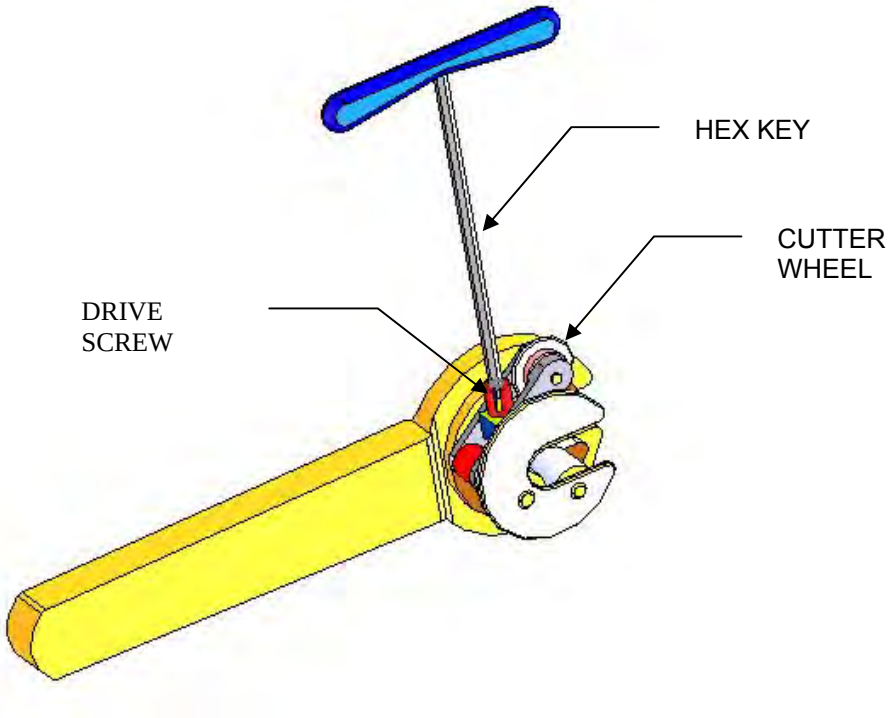


Figure 2: Tube Cutter

Table 6: De-burring Tool and Stem Assembly

SIZE	PART NUMBERS FOR STANDARD STEM ASSEMBLIES:			STEM ASSEMBLY ONLY,
	DE-BURRING TOOL	STEM ASSEMBLY	NATIONAL STOCK NUMBER	SKYDROL[1] (NO NSN)[2]
3/16	D9851-14	D9851-13-03[2]	5110-00-163-5980	D9759-13-03
1/4	D9851-14	D9851-13-04	5110-00-005-5650	D9759-13-04
5/16	D9851-14	D9851-13-05	5110-00-006-0491	D9759-13-05
3/8	D9851-14	D9851-13-06	5110-00-133-1477	D9759-13-06
1/2	D9850-14	D9850-13-08	5110-00-003-0535	D9758-13-08
5/8	D9850-14	D9850-13-10	5110-00-003-0536	D9758-13-10
3/4	D9850-14	D9850-13-12	5110-00-003-0537	D9758-13-12
1	D9849-15	D9849-13-16	5110-00-784-7946	D9757-13-16
1 1/4	D9849-15	D9849-13-20	5110-00-784-7947	D9857-13-20
1 1/2	D9849-15	D9849-13-24	5110-00-784-7950	D9857-13-24

Any tubing with an I.D. less than .150" will have to be deburred using the solid spiral flute deburring tool instead. The part number of the solid spiral flute deburring tool is D10210 (NSN 5110-01-085-7135).

(1) These stem assemblies are compatible with Skydrol or similar fluids.

(2) Stem utilizes same Deburring tool.

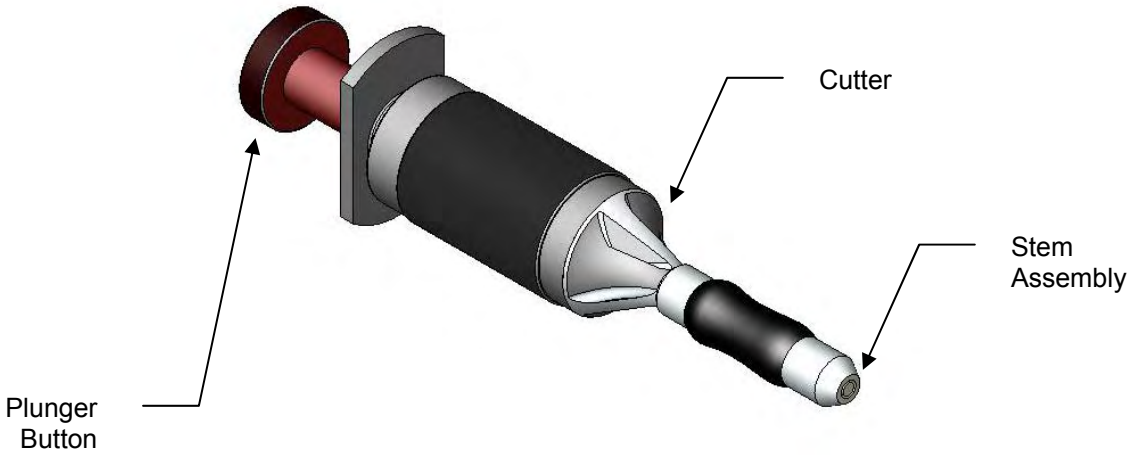


Figure 3: De-burr Tool

Table 7: Making Insertion Marks Without Insertion Marking Tool

TUBE OD	"A"	"B"	PART NUMBER
3/16"	.473"	.773"	DLT5302-013-01
1/4"	.615"	.915"	
5/16"	.655"	.955"	
3/8"	.690"	.990"	
1/2"	1.193"	1.493"	DLT5302-031-01
5/8"	1.233"	1.533"	
3/4"	1.303"	1.603"	
1"	1.448"	1.748"	DLT5302-040-01
1 1/4"	1.550"	1.850"	
1 1/2"	1.675"	1.975"	

Locate points at "A" and "B" distances from the end of the tube. The distance "A" is the minimum insertion depth, and "B" is the maximum insertion depth. The insertion mark made on the tube must extend between "A" and "B".

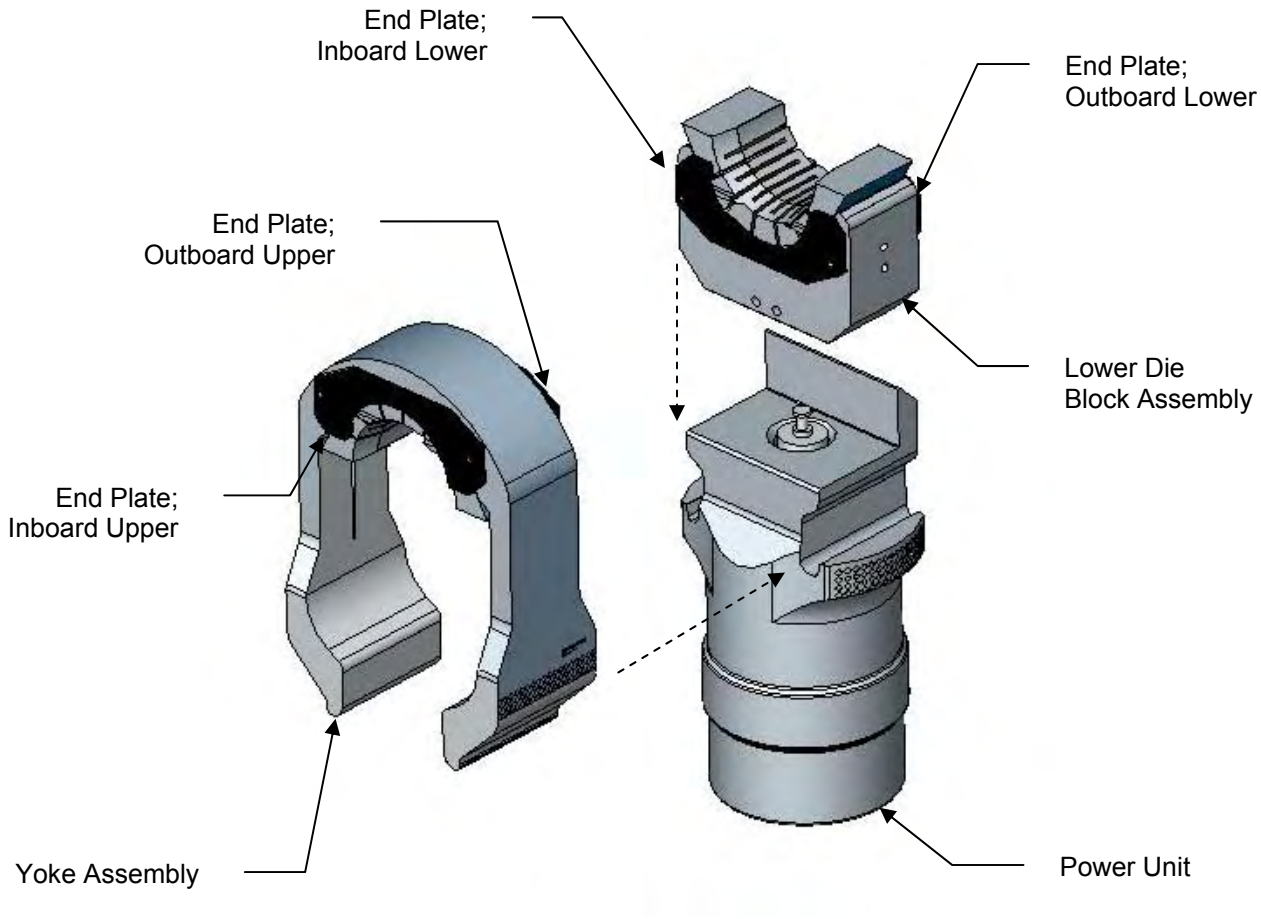
Figure 4: Insertion Marking Tool

Table 8: Power Unit, Head Assembly, Die (0-3000 psi)

TUBE OD	FITTING SIZE	POWER UNIT	HEAD ASSEMBLY	DIE
3/16"	-03	DLT05MAPW0000	DLT05PSHA3003	DLT05PSDI3003
1/4"	-04	DLT05MAPW0000	DLT05PSHA3004	DLT05PSDI3004
5/16"	-05	DLT10MAPW0000	DLT10PSHA3005	DLT10PSDI3005
3/8"	-06	DLT10MAPW0000	DLT10PSHA3006	DLT10PSDI3006
1/2"	-08	DLT20MAPW0000	DLT20PSHA3008	DLT20PSDI3008
5/8"	-10	DLT20MAPW0000	DLT20PSHA3010	DLT20PSDI3010
3/4"	-12	DLT30MAPW0000	DLT30PSHA3012	DLT30PSDI3012
1"	-16	DLT40MAPW0000	DLT40PSHA3016	DLT40PSDI3016
1 1/4"	-20	DLT40MAPW0000	DLT40PSHA3020	DLT40PSDI3020
1 1/2"	-24	DLT40MAPW0000	DLT40PSHA4024	DLT40PSDI4024

Table 9: End Plates and Screw (0-3000 psi)

FITTING SIZE	END PLATES				SCREW, SOCKET HEAD, FLAT
	INBOARD UPPER	INBOARD LOWER	OUTBOARD UPPER	OUTBOARD LOWER	
-03	DLT05PSEU3004	DLT05PSEL3004	DLT05PSFU3003	DLT05PSFL3004	DLT91253
-04	DLT05PSEU3004	DLT05PSEL3004	DLT05PSFU3004	DLT05PSFL3004	DLT91253
-05	DLT10PSEU4006	DLT10PSEL4006	DLT10PSFU3005	DLT10PSFL4006	DLT91253
-06	DLT10PSEU4006	DLT10PSEL4006	DLT10PSFU4006	DLT10PSFL4006	DLT91253
-08	DLT20PSEU4008	DLT20PSEL4008	DLT20PSFU4008	DLT20PSFL4008	DLT91253
-10	DLT20PSEU4010	DLT20PSEL4010	DLT20PSFU4010	DLT20PSFL4010	DLT91253
-12	DLT30PSEU4012	DLT30PSEL4012	DLT30PSFU4012	DLT30PSFL4012	DLT91253
-16	DLT40PSEU3016	DLT40PSEL3016	DLT40PSFU3016	DLT40PSFL3016	DLT91253
-20	DLT40PSEU3020	DLT40PSEL3020	DLT40PSFU3020	DLT40PSFL3020	DLT91253
-24	DLT40PSEU4024	DLT40PSEL4024	DLT40PSFU4024	DLT40PSFL4024	DLT91253



Note: The Head Assembly is the combination of the Lower Die Block Assembly and the Yolk Assembly

Figure 5: Head Assembly, Lower Die Block Assembly, and Power Unit

Table 10: Inspection Gauge (0-3000 psi)

FITTING SIZE	GAUGE		INSIDE DIAMETER "A" +/- .002 (Inches)	INSIDE LENGTH "B" +/- .003 (Inches)
	PERMASWAGE® NUMBER	NATIONAL STOCK NO.		
-03	D12-9892-03	5220-00-005-5635	.247	.340
-04	D12-9892-04	5220-00-005-5636	.315	.460
-05	D12-9892-05	5220-00-005-5637	.381	.500
-06	D12-9892-06	5210-00-005-5638	.447	.584
-08	D12-9892-08	5210-00-004-4912	.606	1.020
-10	D12-9892-10	5210-01-251-3823	.735	1.020
-12	D12-9892-12	5210-00-004-4914	.863	1.020
-16	D12-9892-16	5220-00-882-7951	1.144	1.160
-20	D12-9892-20	5220-00-922-1445	1.390	1.406
-24	D12-9892-24	5220-00-003-0506	1.680	1.420

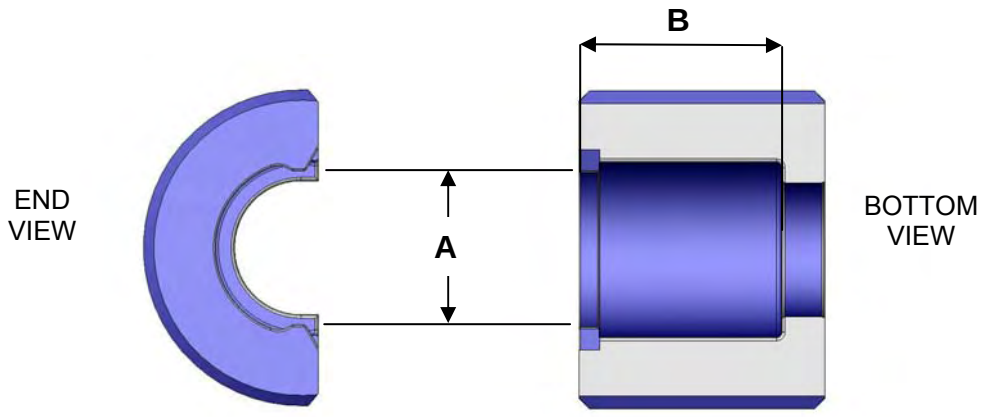
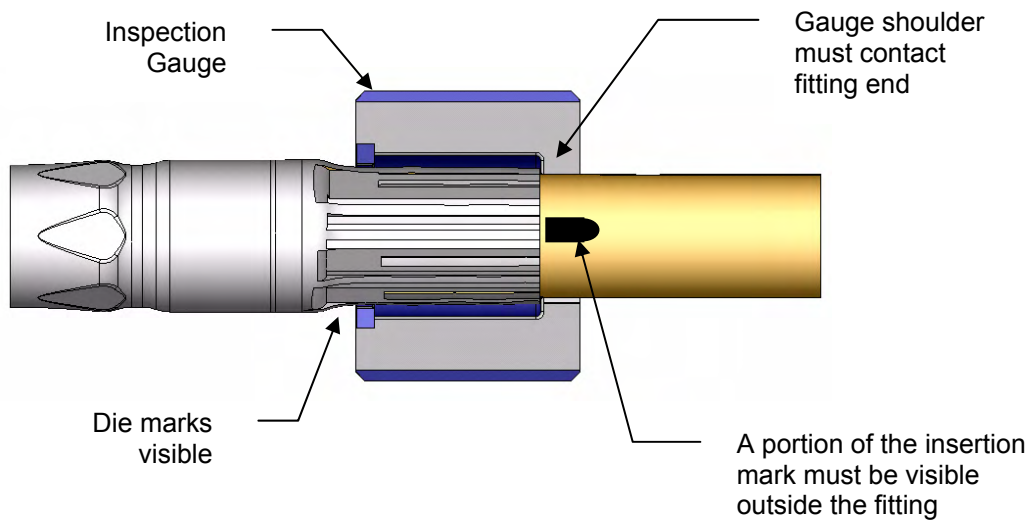


Figure 6: Inspection Gauge



Note: If inspection gauge does not fit properly over the swaged fitting, re-swage the fitting. If dimensions of swaged fitting are still not satisfactory, contact you Designed Metal Components representative for assistance.

Figure 7: Using Inspection Gauge

24. TUBE REPAIR TECHNIQUES

25. Four basic types of tubing system failures lend themselves to permanent repair using Permaswage techniques.

a. Type 1: Small Hole or Short Crack in Tube.

b. Type 2: Lengthwise Crack in Tube (type a and b)

c. Type 3: Leaking Tube or Damaged Fitting Associated with Elbow, Tee, or Cross

d. Type 4: Damaged End Fitting (type a through f)

26. The failure types and recommended repair procedures (one per page) are as follows:

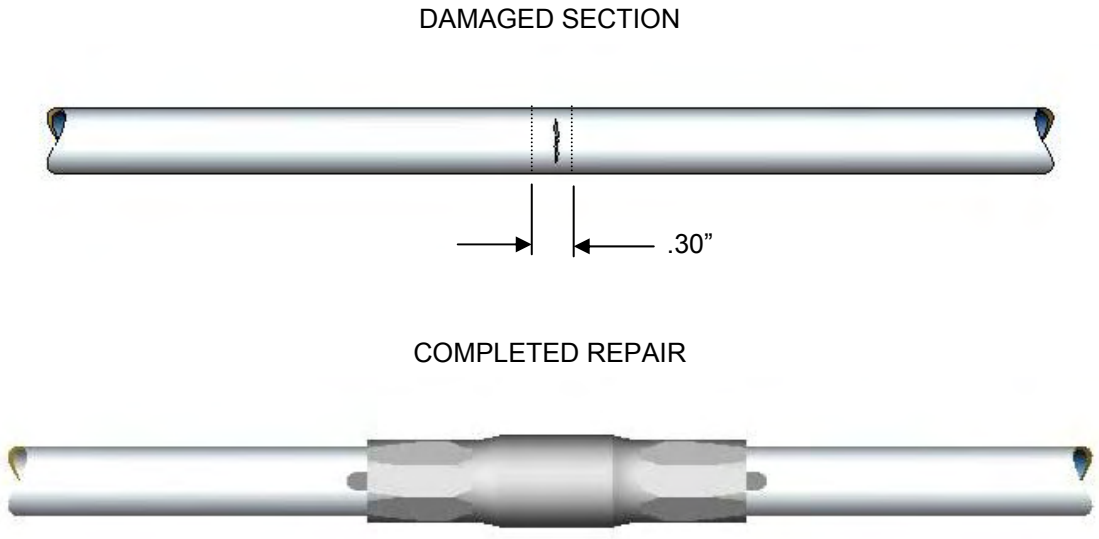
---

27. TYPE 1 - Small Hole or Short Crack in Tube

a. Make one or two cuts as necessary to allow removal of damaged tube section. (If two cuts are required, and the distance between cuts exceeds 0.30", use repair TYPE 2.) See Figure 8 below.

b. Cut the tube only after checking to assure enough space is available to operate the swage tool.

c. Replace removed section of tube with a compatible Permaswage union fitting.



D10036 (-06 thru –16)
D10136 (-20 and –24)

Figure 8: Type 1 Damage Repair

28. <u>TYPE 2a - Lengthwise Crack in Tube (Crack Longer Than 0.30")</u>

a. Make two cuts to allow removal of damaged section of tube. Cut the tube only after checking to assure enough space is available to operate the swage tool. See Figure 9 below.

b. Use a tube splice and two compatible Permaswage union fittings to recreate the section of tubing which was removed. Assemble these parts into the line being repaired before you swage the fittings.

c. Swage each end of the fittings.

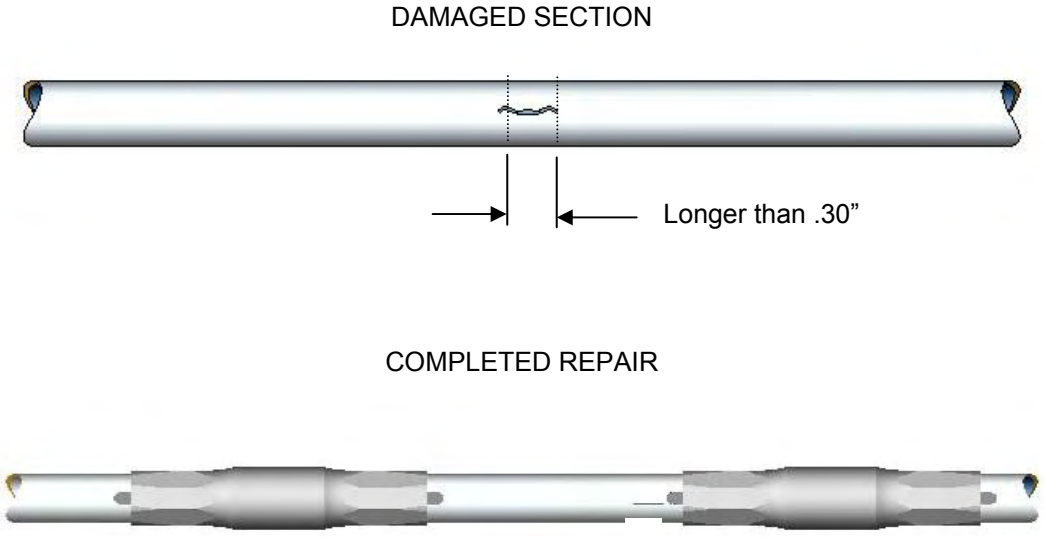


Figure 9: Type 2a Repair, Crack is Longer than 0.30”

29. TYPE 2b - Lengthwise Crack in Tube

a. Repair using Extended Length Permaswage. Part number D10339. See Figure 10 below.

b. Make one cut to allow removal of damaged section of tube. Use Table 11 (Below) for the required gap length. Cut the tube only after checking to assure enough space is available to operate the swage tool.

c. Use one compatible Extended Permaswage union fitting to recreate the section of tubing which was removed. Assemble this part onto the line being repaired before you swage either end of the fitting.

d. Swage each end of the fitting.

Table 11: Extended Length Fittings

Tube Size (inches)	**Fitting Size**	**Req. Gap Length "L"** (inches)
3/16	-03	2.25
1/4	-04	2.25
5/16	-05	2.25
3/8	-06	2.25
1/2	-08	3.70
5/8	-10	3.70
3/4	-12	3.70
1	-16	5.25
1-1/4	-20	5.25
1-1/2	-24	5.25

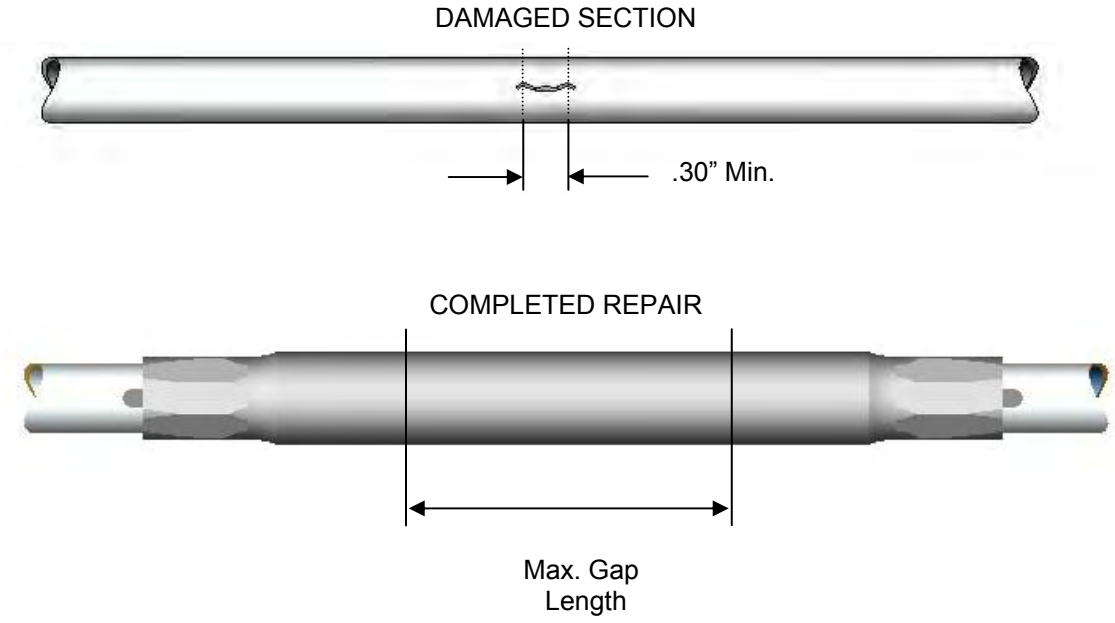


Figure 10: Type 2b Repair using extended length Permaswage®

30. TYPE 3 - Leaking Tube or Fitting Associated with Elbow, Tee, or Cross

a. Cut out defective elbow, tee, or cross. Cut the tube only after checking to assure enough space is available to operate the swage tool. See Figure 11 below.

b. Swage tube splices to a compatible Permaswage elbow, tee, or cross fitting. Do this to re-create section of tubing system which was removed.

c. Swage each leg (tube) of this assembly to the tubing being repaired. Use Permaswage union fittings.

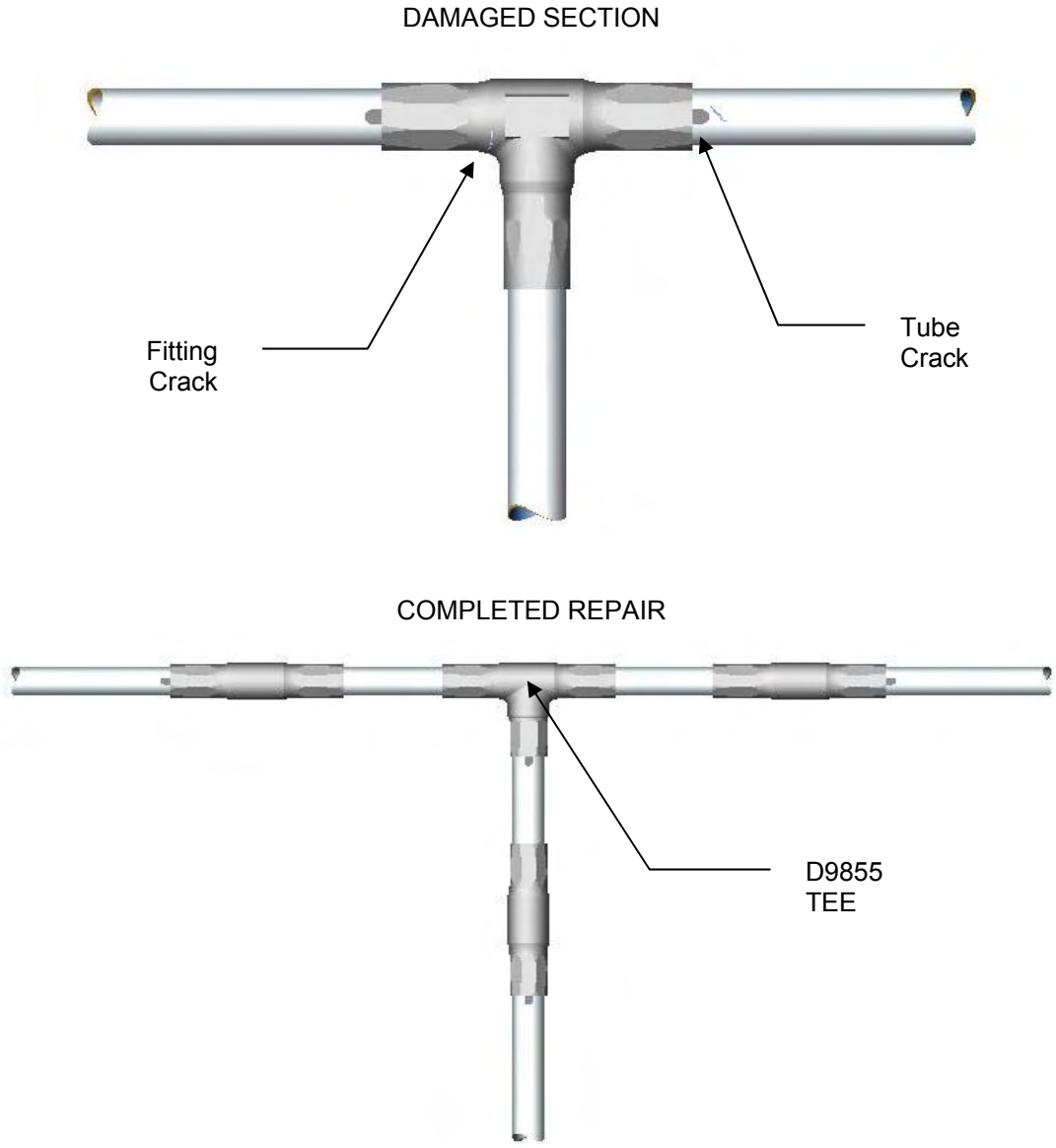


Figure 11: Type 3 Repair

31. TYPE 4a - Damaged Tube or End Fitting (flared, female)

a. Cut off the flared end of the tube as shown in Figure 12 (Below). Refer to Table 12 (Below) to determine the cut-off length ("L"). Use of these cut-off lengths permits repair of the line without splicing new tubing into the line.

b. Replace the removed fitting with a compatible Permaswage D10010 flared sleeve and D10006 coupling nut. (Insert the end of the tube being repaired into the flared sleeve as far as possible before swaging. This will duplicate the original overall length of the assembly.)

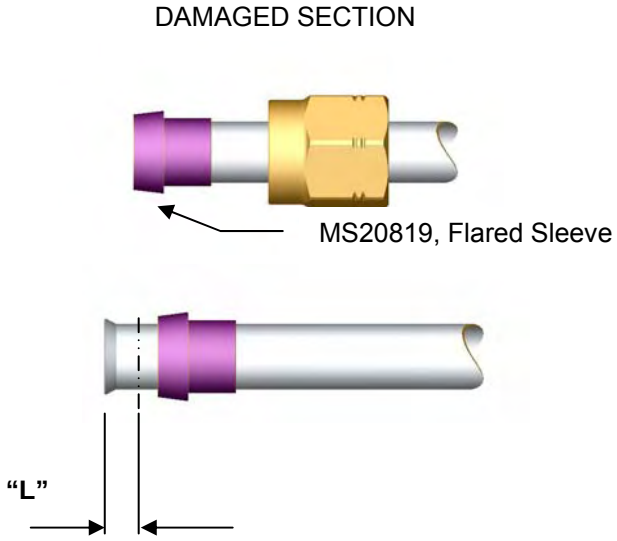


Table 12: Cut-Off Lengths for Flared Fittings, Female

Tube Size (inches)	Fitting Size	"L" (+/- .010)
3/16	-03	.282"
1/4	-04	.275"
5/16	-05	.275"
3/8	-06	.226"
1/2	-08	.243"
5/8	-10	.204"
3/4	-12	.234"
1	-16	1.647"
1-1/4	-20	1.035"
1-1/2	-24	1.045"

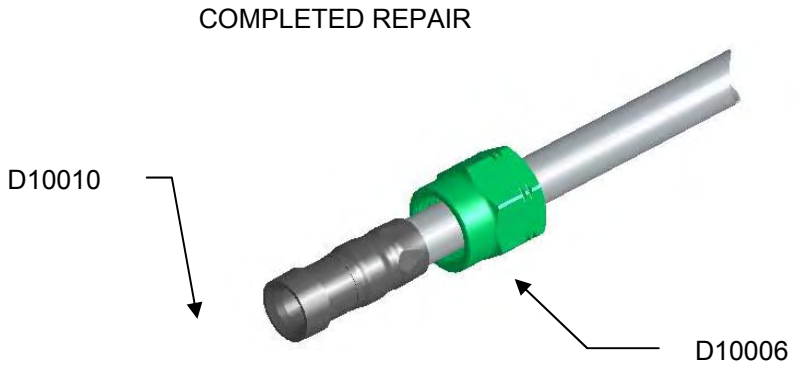


Figure 12: Type 4a Repair

32. TYPE 4b - Damaged Tube or End Fitting (flareless, female)

a. Cut off the flared end of the tube as shown in Figure 13 (Below). Refer to Table 13 (Below) to determine the cut-off length ("L"). Use of these cut-off lengths permits repair of the line without splicing new tubing into the line.

b. Replace the removed fitting with a compatible Permaswage D10007 flared sleeve and D10006 coupling nut. (Insert the end of the tube being repaired into the flared sleeve as far as possible before swaging. This will duplicate the original overall length of the assembly.)

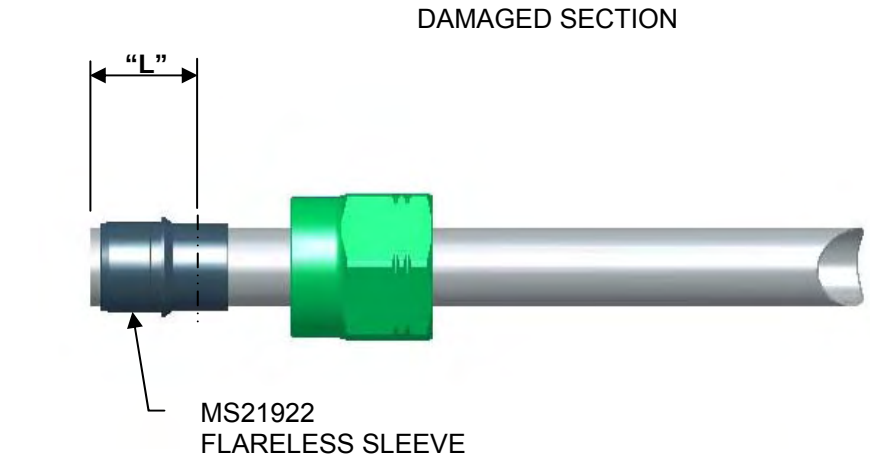


Figure 13: Type 4b Repair

Table 13: Cut-Off Lengths for Flareless, Female

Tube Size (inches)	Fitting Size	"L" (+/- .010)
3/16	-03	.432"
1/4	-04	.541"
5/16	-05	.557"
3/8	-06	.508"
1/2	-08	.588"
5/8	-10	.600"
3/4	-12	.628"
1	-16	2.110"
1-1/4	-20	1.456"
1-1/2	-24	1.504"

33. <u>TYPE 4c - Damaged End Fitting (lipseal, female, -3 through -16)</u> Replacing MR54040 and MR44000P internally swaged, and R44275PT butt welded, female lipseal assemblies in sizes -3 through -16

a. Cut off the damaged fitting at a distance ("L") from the sealing surface as shown in Figure 14 (Below). Refer to Table 14 (Below) to determine the cut-off length ("L").

b. Replace the removed fitting with a compatible Permaswage DD00200A lipseal fitting. (Insert the end of the tube being repaired into the lipseal fitting as far as possible before swaging. This will duplicate the original overall length of the assembly.)

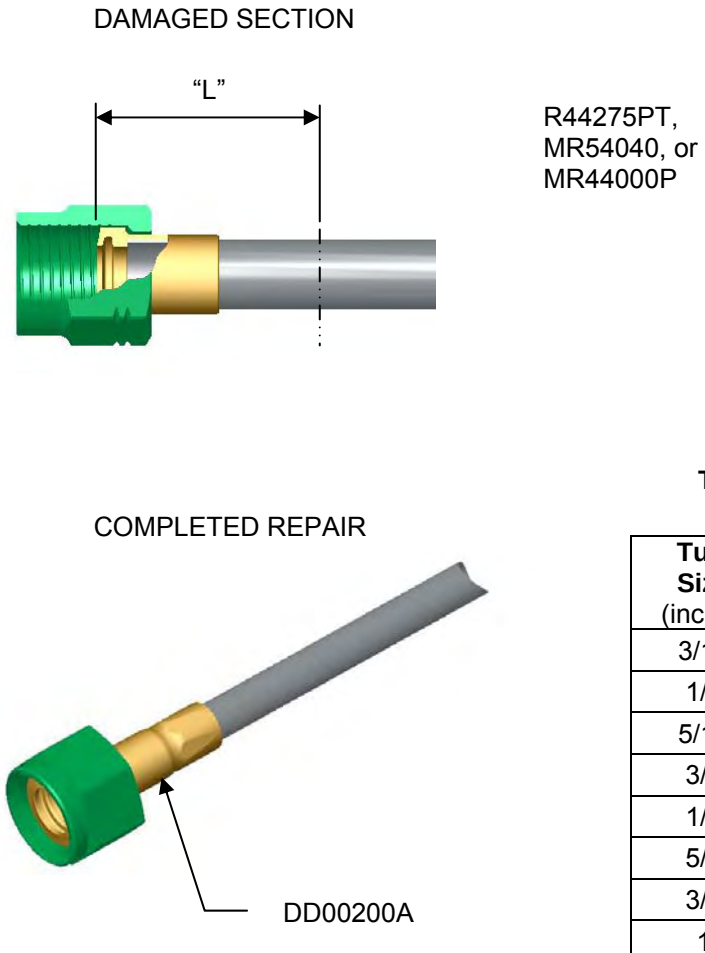


Figure 14: Type 4c Repair

Table 14: Cut-Off Lengths for Lipseal, Female

Tube Size (inches)	**Fitting**	**"L" (+/- .010)**
3/16	-03	.940"
1/4	-04	.970"
5/16	-05	.972"
3/8	-06	.995"
1/2	-08	1.075"
5/8	-10	1.120"
3/4	-12	1.105"
1	-16	1.280"
1-1/4	-20	.940"
1-1/2	-24	.970"

34. <u>TYPE 4d - Damaged End Fitting (lipseal, female, -20 and -24)</u> Replacing MR54040 and MR44000P internally swaged, and R44275PT butt-welded, female lipseal assemblies in sizes -20 and -24. Also applies to D11200 externally swaged female lipseal assemblies in all sizes. See Figure 15 below.

a. Cut off damaged fitting at a point where there is enough space in which to operate the swage tool.

b. Swage a compatible Permaswage union fitting to one end of a tube splice. Swage a Permaswage D11200 or DD00200A lipseal fitting to the other end of the same tube splice.

c. Connect the end of this assembly with a union fitting to the end of the tube being repaired.

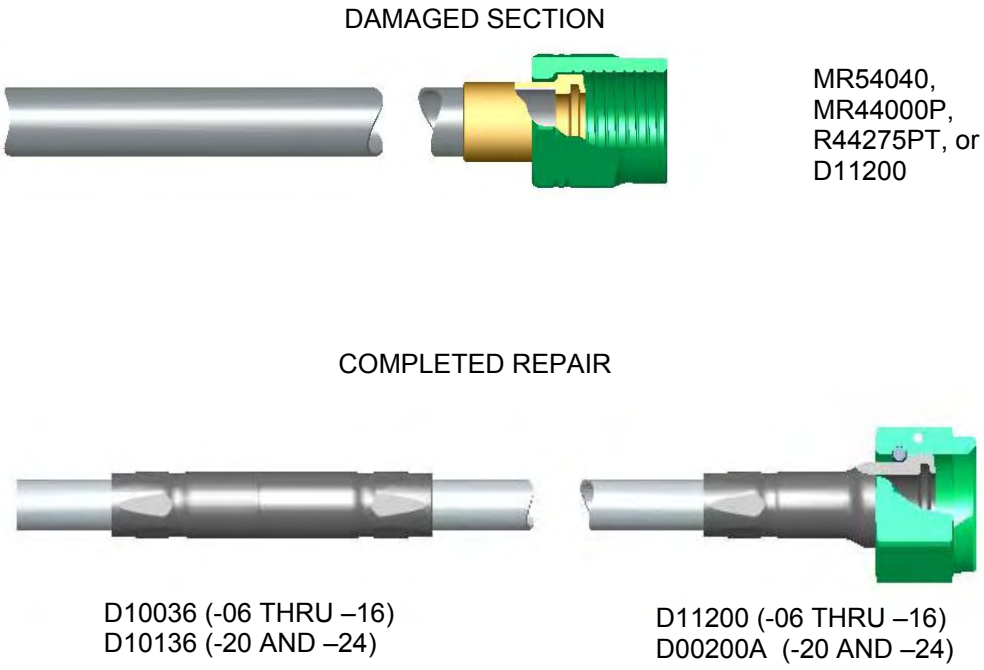


Figure 15: Type 4d Repair

35. <u>TYPE 4e - Damaged End Fitting (lipseal, female, reducer)</u> Replacing R44277PT butt-welded female lipseal reducer assemblies.

a. Cut off the damaged fitting at a distance ("L") from the sealing surface as shown in the Figure 16 (Below). Refer to Table 15 (Below) to determine the cut-off length ("L").

b. Replace the removed fitting with a compatible Permaswage DD00300A lipseal fitting. (Insert the end of the tube being repaired into the lipseal assembly as far as possible before swaging. This will duplicate the original overall length of the assembly.)

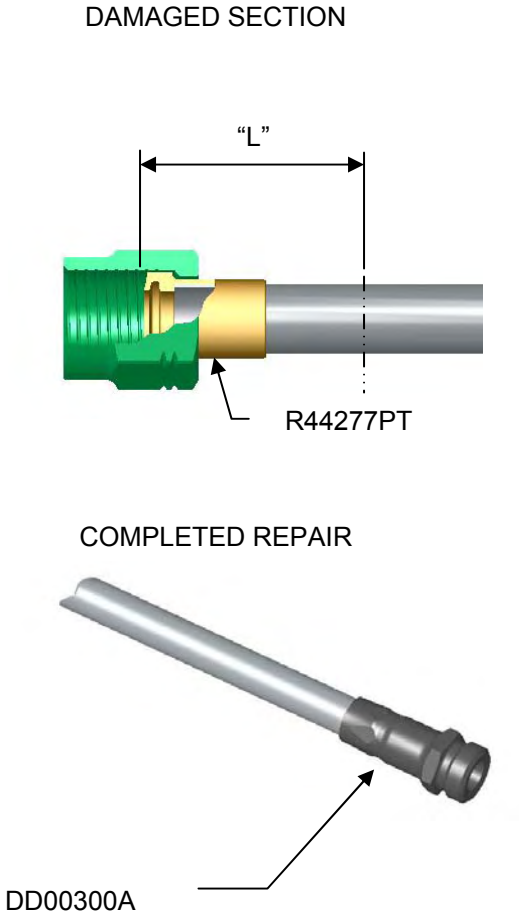


Figure 16: Type 4e Repair

Table 15: Cut-Off Length for Lipseal, Female, Reducer

End 1 (Separable End)	**End 2** (Swage End)	**"L"(+/- .010)**
-04	-03	.702"
-05	-04	.635"
-06	-04	.710"
-08	-04	.710"
-08	-06	.725"
-10	-06	.740"
-10	-08	.797"
-12	-06	.860"
-12	-08	.832"
-12	-10	.862"
-16	-8	.927"
-16	-10	.957"
-16	-12	.887"

36. <u>TYPE 4f - Damaged End Fitting (lipseal, male adapter)</u> Replacing internally swaged, butt-welded, or externally swaged male lipseal fittings: MR54100, MR44100P, or D11007. See Figure 17 below.

a. Cut off damaged fitting at a point where there is enough work area in which to operate the swage tooling.

b. Swage a compatible Permaswage union fitting to one end of a tube splice. Swage a Permaswage D11007 male lipseal adapter fitting to the other end of the same tube splice.

c. Swage the end of this assembly with a union fitting to the end of the tube being repaired.

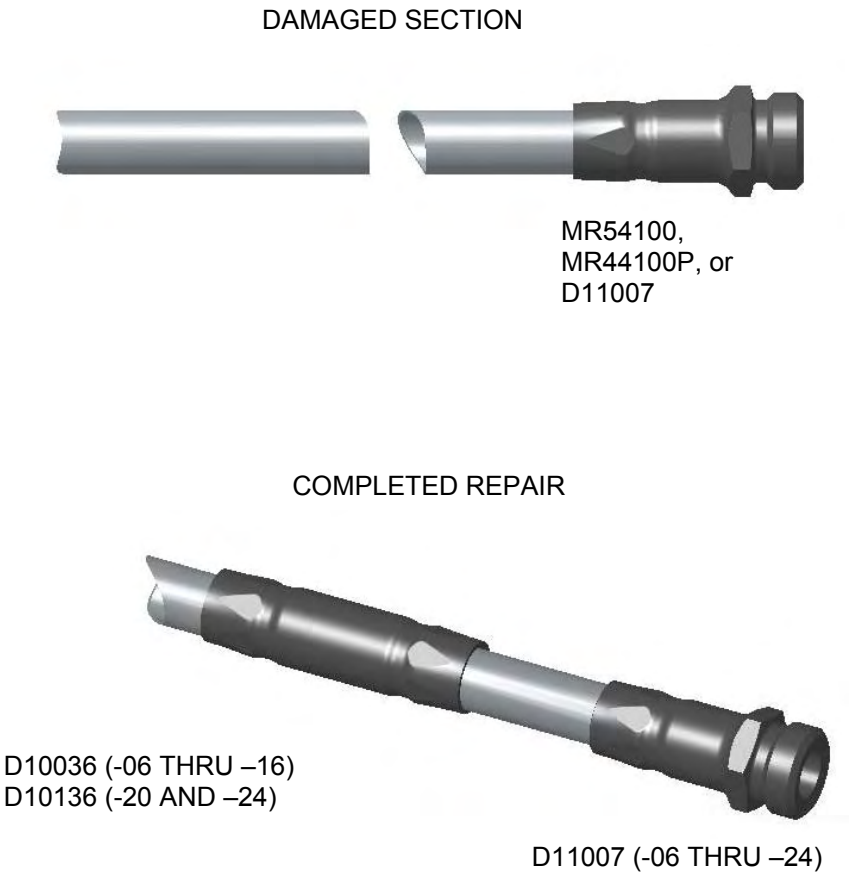


Figure 17: Type 4f Repair

37. FREQUENTLY ASKED QUESTIONS

38. Here are some of the most frequently asked questions (and answers) regarding use of the Permaswage Tube Connecting System:

39. Is it OK to swage a fitting more than once?

- Yes. It's OK to swage a fitting more than once--just be sure that you're using the correct die set. Be sure that your hydraulic pump is delivering the right amount of pressure to the swage tool.

40. If a joint is weeping or leaking, should the fitting be swaged again?

- If a Permaswage joint begins to weep or leak, the leakage will often be stopped by swaging the fitting again.

41. How many fittings can be swaged into a line?

- As many as will fit. We recommend, though, that you allow a minimum distance of one tube diameter between fittings.

42. Is it OK to glue fittings onto tubes?

- No. Do not use glue at any time.

43. BASIC MAINTENANCE

44. This section covers regular inspection, cleaning, and storage of the equipment. Also covered is how to replace the cutter wheel of the tube cutter. Refer to: MCP-016, Inspection Criteria of DLT Series Tools, and DMC-1320, DLT Preventive Maintenance.

45. Inspection and Cleaning of Tooling

NOTE

Parts of this tooling are subjected to extremely high forces -- the following procedures must be performed as often as specified to ensure safe and successful operation.

46. Refer to Table 16 for inspection and cleaning procedures:

Table 16: Inspection and Cleaning Procedures

PROCEDURE PERFORMED	HOW OFTEN
Check All Components. If any deep scratches, gouges, dimples or other abnormalities appear, discontinue use and contact Item Manager	Before each use.
Check Die Sets. Upper and lower halves must be a serialized set. They must be clean. Apply DMC Swage Lube to the heads and dieblocks prior to installing the dies.	Before each use.
Check Connection Points. Components must be clean in all areas where they contact each other.	Each time components are connected.
Check Tube Cutter. Cutting wheels must be sharp. Rollers must be parallel and not wobbly.	Before each use.
Lubricate Tube Cutter. Lubricate ratchet, rollers and cutter wheel with light oil.	As required to ensure ease of operation

47. Storing Equipment After Use

48. Replace protective caps over all connectors before storing equipment. Storing the equipment without replacing the protective caps can cause the equipment to fail.

49. How to Replace Cutter Wheel of Tube Cutter (See Figure 2)

50. The cutter wheel in the tube cutter should be replaced whenever it becomes too dull to cut efficiently. It should also be replaced if it becomes damaged in any way.

51. Disassembly

a. Tighten drive screw until cutter pivot pin becomes accessible.

b. Remove cutter pivot pin. Cutter wheel will now slide out easily.

51. Reassembly

a. Slide new cutter wheel into place and secure with pivot pin.

b. Lubricate with light machine oil.

52. No other regular maintenance is required for any component in the tool kit.

53. TROUBLESHOOTING

54. Refer to Table 17 for general troubleshooting of the tooling:

Table 17: General Troubleshooting

PROBLEM	POSSIBLE CAUSE	SOLUTION
Fitting does not swage properly.	Pump not supplying 10,000 +/- 250 psig to swage tool.	Check output from pump.
	Using incorrect dies.	Use correct dies. Reswage.
	Dies are not clean.	Clean dies. Reswage.
	Dies are worn or damaged.	Replace dies. Reswage.
	QD failure.	Fix or replace QD.
Gauge shoulder does not contact end of fitting.	Components were not correctly positioned before swaging.	Reswage, making sure the swage tool is properly positioned.
End of fitting doesn't touch the insertion mark on the tube.	Fitting was not properly located on the tube before pressure was applied.	Replace fitting.

55. RETURN OF TOOLING FOR EVALUATION OR REPAIR

56. Repairs are only authorized by Designed Metal Components (formerly Deutsch Metal Components) company certified mechanics.

57. Repair by an uncertified mechanic will void the warranty. Unauthorized repairs may cause the equipment to perform in an unsatisfactory manner. Contact your DMC representative for information regarding return of swage tooling for evaluation and/or repair.

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION AND MAINTENANCE

ROSAN FITTINGS

Reference Material

Primer Coating, Zinc Chromate TT-P-1757

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Record of Applicable Technical Directives

None

1. GENERAL.

2. Rosan fittings are designed to function as unions with one end connected to the port of a unit and the other end connected to the tube assemblies. All maintenance levels are authorized to remove and replace damaged Rosan fittings.

3. PORT PREPARATION FOR ROSAN FITTINGS.

4. Port preparation is only authorized at the Depot Level. Figure 1 shows the standard port that will accept Rosan fittings (Figure 2). Two main functions, threading and broaching, are required to prepare a port.

5. THREADING. To thread a standard port PS-10035, proceed as follows:

a. Select correct porting tool, based on port thread size from Table 1. Table 2 shows details of porting tool.

b. Select a drill with a diameter approximately .015 inch to .030 inch smaller (depending on process standards with respect to material and size) than specified as Controlled Minor Diameter of Table 1.

c. Using porting tool, align pilot and machine port to specified depth M of Table 1.

d. Tap port to produce correct MIL-S-8879 thread B as indicated in Table 1.

e. Remove burrs and chips.

6. BROACHING. Broaching is the process in which serrations are cut into the counterbore wall of the port (Table 3), using one of the Rosan series broaching tools shown in Table 4. The choice of tool is determined by the size of the port, material to be broached, and the configuration of the component boss. Instructions for using the various broaching tools are described below.

7. Broaching With Broaching Tool RFOPB-5000 Series. The broaching tool shown in Table 5 may be hand held or used in a hydraulic press. To broach a port with the broaching tool RFOPB5000 series, proceed as follows:

CAUTION

The nut is for cutter removal only; it is not a stop. Always back off nut when broaching.

a. Insert broach tool into port. Before actual broaching, cutter teeth will rest on port surface, while tool body is free to move up or down.

b. Apply a force to mandrel while holding body. As the teeth cut into the aluminum, the body approaches the port surface. Broaching is complete when mandrel collar stops against inside body stop.

c. Remove tool from port by turning nut in a clockwise direction against body; mandrel will now move up and remove cutting teeth from port.

d. Remove burrs and chips.

8. Broaching With Other Broaching Tools. The broaching tool RFOPB5000 series (above) requires broaching loads of 1,500 lbs to 10,000 lbs in 7075-T73 material, and 3,300 lbs to 20,000 lbs in 4130 steel, depending on port size. Since there are many housings that will not accept these loads, use other broaching tools shown in Table 4.

9. Broaching With Broaching Tool RFOPB5000HDB Series. The broaching tool RFOPB5000HDB series shown in Table 6 is available in five sizes (02, 03, 04, 06, and 08). It has a one-piece cutter and is designed to cut materials of Rockwell hardness up to 42 HRC. To broach a port with the broaching tool RFOPB5000HDB series, proceed as follows:

a. Screw stud into port until 20 degree angle surface of stud touches 20 degree angle surface of port. Snug down, using hex at top of stud.

b. Slide cutter over stud, allowing it to set on port surface. Lubricate counterbore area of port with cutting oil.

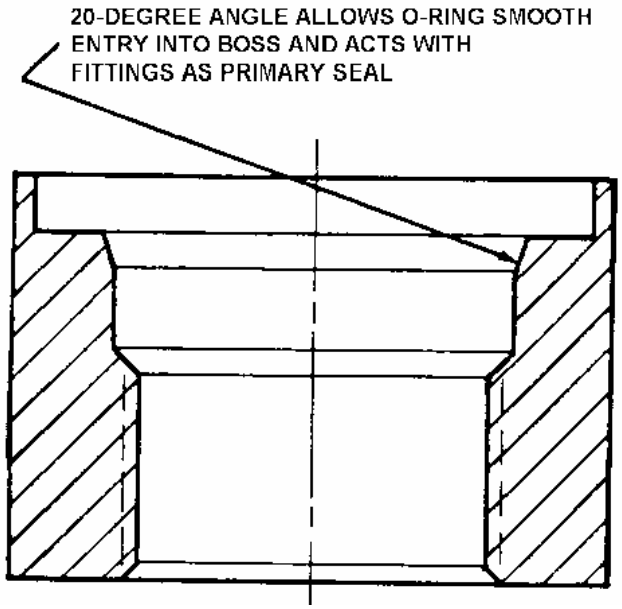

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Figure 1. Port (Standard PS10035)

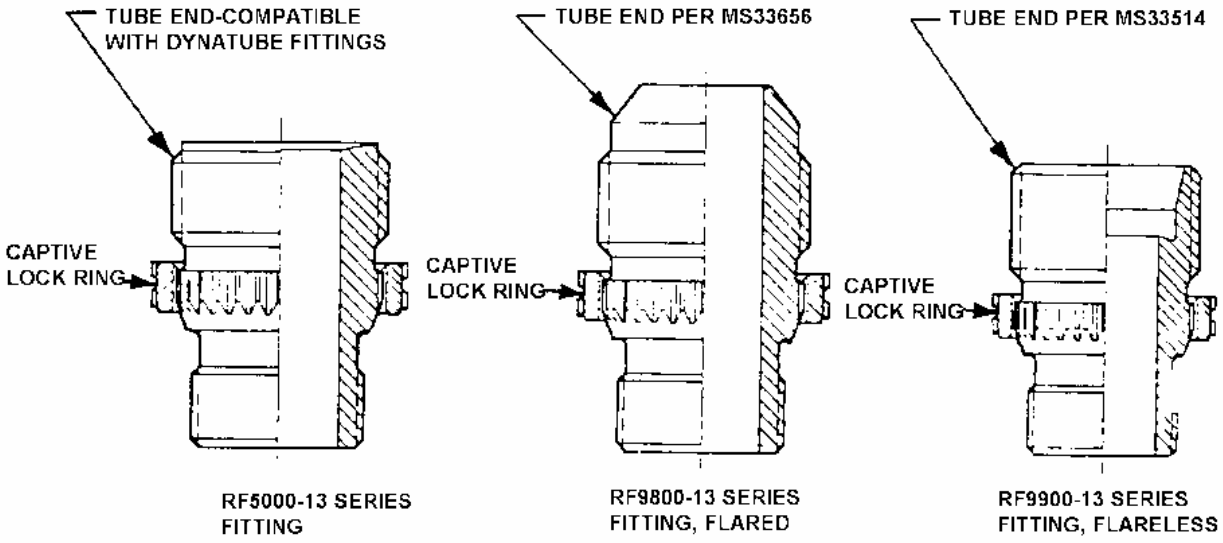

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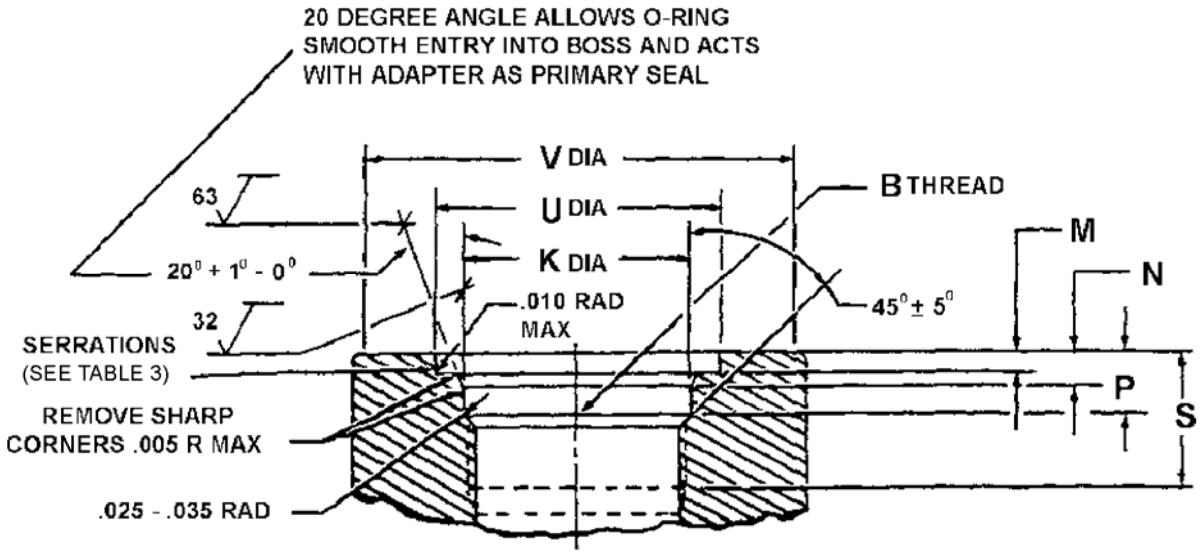
Figure 2. Rosan Tube End Fittings

Table 1. Port (Standard PS10035) and its Relative Dimensions



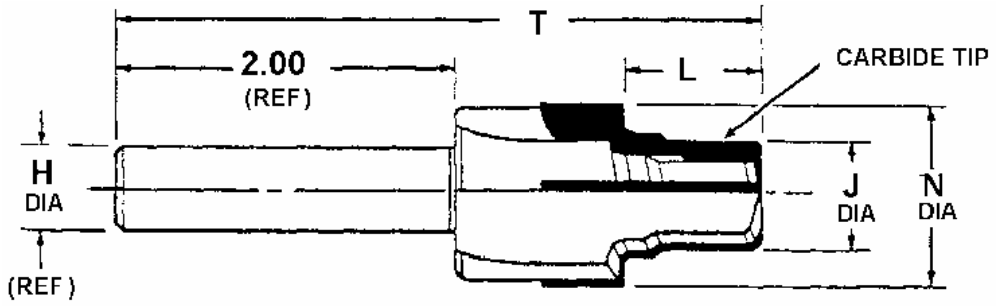
PS 10035 Dash No.	Tube OD Nom.	B MIL-S-8879 Class 3B	Controlled Minor Dia. (Note 4)	K (Note 1) Dia. +.002 -.000	M +.010 -.000	N +.005 -.000	P +.005 -.000	S Min Full Thd. Depth	U (Note 2) Dia. +.003 -.000	Porting Tool No. (Ref.)	V (Note 6) Min. Boss Dia.
-02	.125	.2160-28 UNJF	.1827 .1857	.254	.088	.153	.296	.507	.381	RPT 02	.500
-03	.188	.2500-28 UNJF	.2167 .2197	.286	.088	.153	.296	.568	.448	RPT 03	.620
-04	.250	.3125-24 UNJF	.2734 .2764	.339	.088	.153	.296	.568	.495	RPT 04	.680
-05	.312	.3750-24 UNJF	.3359 .3389	.401	.088	.153	.296	.594	.601	RPT 05	.790
-06	.375	.4375-20 UNJF	.3903 .3933	.464	.103	.168	.311	.631	.675	RPT 06	.850
-08	.500	.5625-18 UNJF	.5099 .5129	.582	.103	.168	.311	.672	.784	RPT 08	1.040
-10	.625	.6875-24 UNJEF	.6484 .6514	.725	.103	.168	.311	.693	1.015	RPT 10	1.170

Table 1. Port (Standard PS10035) and its Relative Dimensions (Cont)

PS 10035 Dash No.	Tube OD Nom.	B MIL-S-8879 Class 3B	Controlled Minor Dia. (Note 4)	K (Note 1) Dia. +.002 -.000	M +.010 -.000	N +.005 -.000	P +.005 -.000	S Min Full Thd. Depth	U (Note 2) Dia. +.003 -.000	Porting Tool No. (Ref.)	V (Note 6) Min. Boss Dia.
-12	.750	.8125-20 UNJEF	.7653 .7683	.899	.103	.168	.343	.763	1.139	RPT 12	1.420
-14	.875	.9375-20 UNJEF	.8903 .8933	1.030	.103	.168	.343	.800	1.311	RPT 14	1.540
-16	1.000	1.1250-18 UNJEF	1.0714 1.0744	1.162	.103	.168	.343	.806	1.427	RPT 16	1.670
-20	1.250	1.3125-18 UNJEF	1.2599 1.2629	1.387	.130	.195	.375	.838	1.750	RPT 20	1.980
-24	1.500	1.6250-18 UNJEF	1.5724 1.5754	1.664	.130	.195	.375	.877	2.005 2.000	RPT 24	2.230
-32	2.000	2.1250-16 UNJ	2.0627 2.0657	2.202	.130	.236	.416	1.050	2.521 2.516	RPT 32	2.860

Notes:
1. Thread pitch diameter and “K” must be concentric within .003 tir.
2. Thread pitch diameter must be concentric within .003 tir to “U” dia.
3. The drill and porting tool method of preparing the machined cavity will aid in maintaining the concentricites shown in Notes 1 and 2.
4. The controlled minor diameter is mandatory when prebroaching of the serrations is planned, using piloted broach tool (Table 5). See Table 2.
5. Dimensions in inches: tolerances unless noted, decimal .XX = ± .015, .XXX = ± .005.
6. The minimum boss diameters shown are satisfactory for use in materials that exhibit minimum shear strengths of 26,000 psi or more. A 10 percent increase in the diameters shown is suggested for sizes -5 through -8, and a 15 percent increase in diameters shown for sizes -10 and above when designing in materials whose shear strength is less than 26,000 psi.

Table 2. Porting Tool



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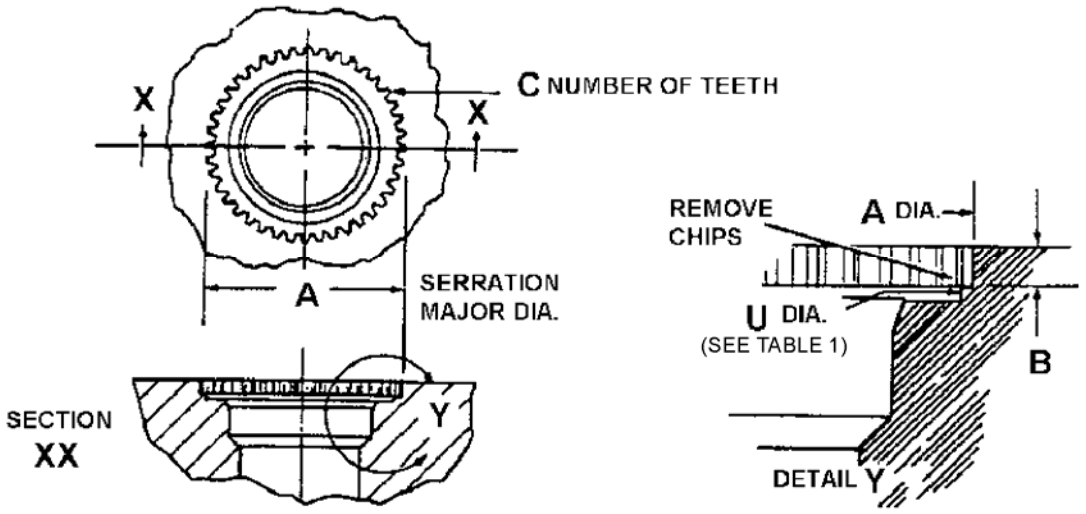
Tool No. (Note 3)	(Ref.) Tube OD	H +.0000 -.0003	J ±.0005	N ±.0003	L ±.005	T (Ref)	Thread MIL-S-8879 UNJ, UNJF & UNJEF (Ref.)	(Ref) Machined Cavity PS 10035 Dash No.
RPT 02 (Note 5)	1/8	.3748	.1842	.3818	.610	4.000	.2160-28	-02
RPT 03 (Note 5)	3/16	.3748	.2182	.4488	.670	4.000	.2500-28	-03
RPT 04 (Note 5)	1/4	.4998	.2749	.4958	.700	4.000	.3125-24	-04
RPT 05	5/16	.4998	.3374	.6018	.725	3.475	.3750-24	-05
RPT 06	3/8	.4998	.3918	.6758	.785	3.535	.4375-20	-06
RPT 08	1/2	.4998	.5114	.7848	.850	3.850	.5625-18	-08
RPT 10	5/8	.4998	.6499	1.0158	.810	3.810	.6875-24	-10
RPT 12	3/4	.4998	.7668	1.1398	.950	4.200	.8125-20	-12
RPT 14	7/8	.7498	.8918	1.3118	.987	4.240	.9375-20	-14
RPT 16	1	.7498	1.0729	1.4278	1.015	4.265	1.1250-18	-16
RPT 20	1 1/4	.7498	1.2614	1.7508	1.020	4.520	1.3125-18	-20
RPT 24	1 1/2	.7498	1.5739	2.0008	1.060	4.560	1.6250-18	-24
RPT 32	2	.9998	2.0642	2.5185	1.265	4.765	2.1250-16	-32

Notes:
1. This tool counterbores, countersinks, and produces a perfect tap drill diameter in one pass. Perfect concentricity is kept since the contours are ground on centers. Cutter geometry is such that these tools can be efficiently used in most common types of materials.
2. Under ordinary conditions this porting tool can be reconditioned with a flute grind between centers.
3. RPT prefix tool shown supersedes RFPT prefix porting tool. The RFPT tool may be used until replacement is necessary.
4. All dimensions are in inches.
5. These tools are solid carbide.

Table 3. Broached Serration Dimensions



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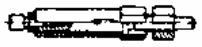
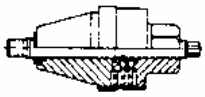
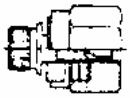
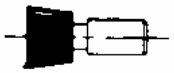
Port No.	A Dia Min.	B Min.	C No. of Teeth
PS10035-02	.408	.061	24
PS10035-03	.478	.061	26
PS10035-04	.524	.061	30
PS10035-05	.635	.061	36
PS10035-06	.710	.073	36
PS10035-08	.826	.073	40
PS10035-10	1.052	.073	38
PS10035-12	1.182	.073	40
PS10035-14	1.354	.073	50
PS10035-16	1.471	.073	36
PS10035-20	1.795	.093	56
PS10035-24	2.045	.093	81
PS10035-32	2.561	.093	102

Notes:
1. Rosan tools per Table 4 must be used to produce proper serrations.
2. Best results in broaching are obtained by using the PRT series of porting tools, since the minor diameter of the thread is prepared to act as guide for the pilot of the broach tool.
3. After serrations are broached, chip removal is required.
4. All dimensions are in inches.

Table 4. Broaching Tools

	Basic Part No.	Broaching Method	Port Sizes
 012t04a	RFOPB5000	Arbor Press Hydraulic Press Hammer	02 through 32
 012t04b	RFOPB5000HDB	Torque	02, 03, 04, 06, 08
 012t04c	RFOPB5000HDC	Torque	08 through 24
 012t04d	RFOP5000WB	Rotary (Wobble Broach Machining)	
 012t04e	RFOPB5000ED2	Electrical Discharge Machining For Hard Materials	

Notes: 1. Broaching tools RFOPB5000WB and RFOPB5000ED2 are available through Rosan, Inc. They are not described in this manual.

c. Position tool body over stud with tapered end down and hex-drive end up. Thread tool body down until it touches cutter.

d. Position wrench on large hex drive of body. Turn hex clockwise until tool body contacts material surface.

e. Loosen tool body by turning large hex counterclockwise 1/2 turn.

f. Position wrench on small hex on stud and turn stud out, lifting cutter from port.

g. Remove chips.

10. Broaching With Broaching Tool RFOPB-5000HDC Series. Broaching tool RFOPB5000HDC series shown in Table 7 is available in sizes (08 through 24). It has a one-piece cutter and is designed to cut material of Rockwell hardness up to 42 HRC. To broach a port with broaching tool RFOPB5000HDC, proceed as follows:

a. Screw tool assembly into port (using hex wrench provided) until 20 degree-angle surface of stud touches 20 degree-angle surface of port.

NOTE

Make sure there is clearance between cutter and material to allow 20 degree angle surface of stud to seat.

b. Use a socket or open end wrench to turn nut clockwise until tool body touches material.

c. Loosen nut by turning nut counterclockwise 1/2 turn.

d. Position wrench on small hex of stud and turn stud out; lift cutter from port.

e. Remove chips.

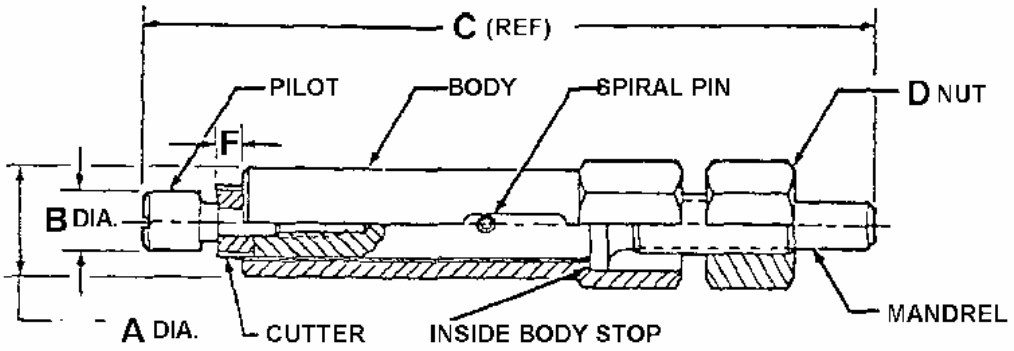
11. INSTALLATION.

Materials Required

Specification or Part Number	Nomenclature
TT-P-1757	Zinc Chromate Primer Coating

12. After port preparation is completed, the port is ready for installation of fitting.

Table 5. Broaching Tools, RFOPB5000 Series



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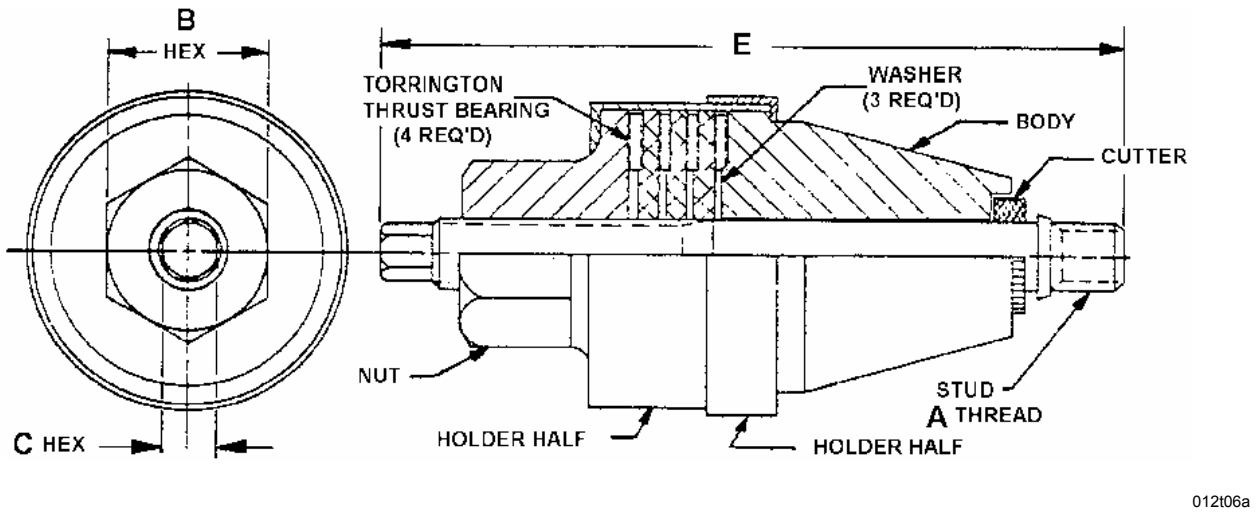
Tool No.	Cavity No. (Ref.) PS 10035	Cutter No. (Replaceable)	A Dia. ±.015	B Dia. +.0000 -.0010	C (Ref.)	D Hex Across Flats	F +.015 -.000
RFOPB5002	-02	RFOPB5002-3	.600	.1822	5.32	.62	.063
RFOPB5003	-03	RFOPB5003-3	.730	.2162	5.32	.75	.063
RFOPB5004	-04	RFOPB5004-3	.790	.2729	5.32	.81	.063
RFOPB5005	-05	RFOPB5005-3	.920	.3354	5.34	.94	.063
RFOPB5006	-06	RFOPB5006-3	.980	.3898	5.42	1.00	.075
RFOPB5008	-08	RFOPB5008-3	1.070	.5094	5.46	1.12	.075
RFOPB5010	-10	RFOPB5010-3	1.290	.6479	5.48	1.31	.075
RFOPB5012	-12	RFOPB5012-3	1.420	.7648	5.54	1.44	.075
RFOPB5014	-14	RFOPB5014-3	1.600	.8898	5.61	1.62	.075
RFOPB5016	-16	RFOPB5016-3	1.730	1.0719	5.62	1.75	.075
RFOPB5020	-20	RFOPB5020-3	2.040	1.2594	5.64	2.25	.095
RFOPB5024	-24	RFOPB5024-3	2.300	1.5719	5.65	2.50	.095
RFOPB5032	-32	RFOPB5032-3	2.810	2.0647	5.65	2.88	.095

Notes:
1. The tool will broach aluminum, magnesium, and many steels with hardness of 32 HRC or less. Successful broaching of harder or tougher material may be accomplished, but tool cutter wear is to be expected.
2. Cutter material is tool steel 61-67 HRC hardness, finish none. Tool finish - black oxide plus oil.
3. All dimensions are in inches.

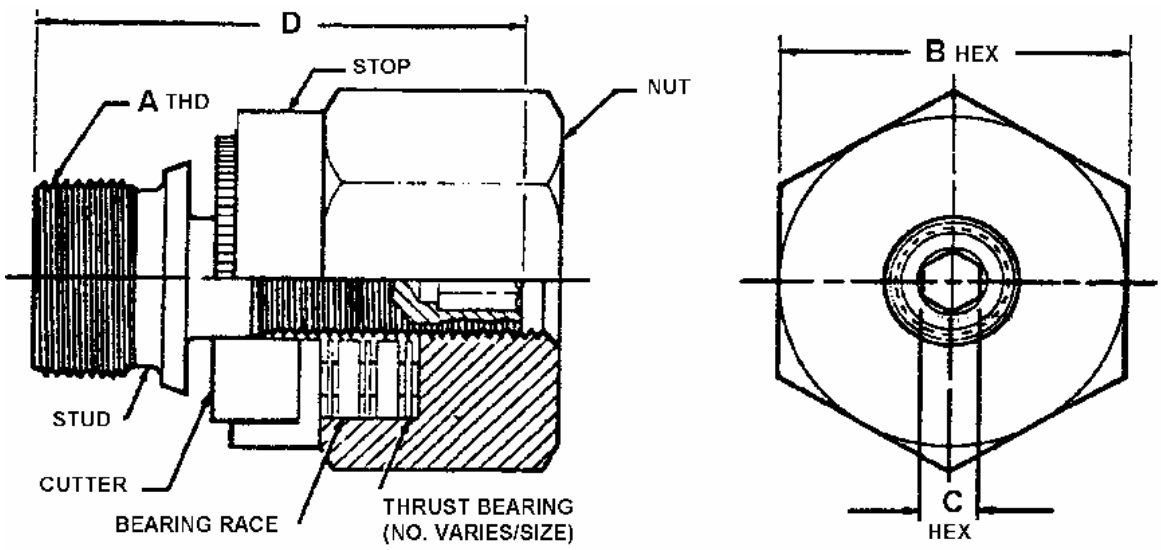
Table 6. Broaching Tool, RFOPB5000 HDB Series



Part No.	Cutter (Note 2)	Torrington Thrust Bearing	A Thread MIL-S-8879 Class 3A	B Hex Ref.	C Hex Ref.	E ±.03	To Produce Serrations For Boss Nos.
RFOPB5002HDB	RFOPB5002HDB5	NTA-512	.2160-28UNJF	.500	.125	3.10	PS10035-02
RFOPB5003HDB	RFOPB5003HDB5	NTA-613	.2500-28UNJF	.625	.172	3.58	PS10035-03
RFOPB5004HDB	RFOPB5004HDB5	NTA-1018	.3125-24UNJF	.750	.218	3.86	PS10035-04
RFOPB5006HDB	RFOPB5005HDB5	NTA-1625	.4375-20UNJF	1.000	.312	4.71	PS10035-06
RFOPB5008HDB	RFOPB5008HDB5	NTA-1828	.5625-18UNJF	1.000	.375	4.96	PS10035-08

Notes: 1. Lubricate bearings with Lubriplate 130AAA.
2. Ten extra cutters are provided with each tool.
3. All dimensions are in inches.

Table 7. Broaching Tool, RFOPB5000 HDC Series



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Tool No.	Cutter (Note 2)	A Thd. MIL-S-8879 Class 3A	B Hex Ref.	C Hex Ref.	D +.040 -.010	Thrust Bearing		Bearing Race No. Req'd	To Produce Serrations For Boss No.
						Part No.	No. Req'd		
RFOPB5008HDC	RFOPB5008HDC3	.5625-18UNJF	1.000	.188	2.110	NTA-613	3	2	PS10035-08
RFOPB5010HDC	RFOPB5010HDC3	.6875-24UNJEF	1.250	.250	2.030	NTA-916	2	1	PS10035-10
RFOPB5012HDC	RFOPB5012HDC3	.8125-20UNJEF	1.375	.250	2.410	NTA-1018	3	2	PS10035-12
RFOPB5014HDC	RFOPB5014HDC3	.9375-20UNJEF	1.500	.250	2.420	NTA-1220	3	2	PS10035-14
RFOPB5016HDC	RFOPB5016HDC3	1.1250-18UNJEF	1.625	.375	2.265	NTA-1423	2	1	PS10035-16
RFOPB5020HDC	RFOPB5020HDC3	1.3125-18UNJEF	2.000	.375	2.525	NTA-1828	2	1	PS10035-20
RFOPB5024HDC	RFOPB5024HDC3	1.6250-18UNJEF	2.250	.375	2.750	NTA-2233	2	1	PS10035-24

Notes: 1. All dimensions are in inches.
2. Ten extra cutters are provided with each tool.

13. TOOLS. Various tools for installing fittings are available in kit form (Figure 3). Each kit contains an O-ring installation tool (Table 8), a combination lock ring drive tool and wrench (Table 9), and a lock ring puller (Table 10). Table 11 lists the installation kits for fittings RF9800 and RF9900 series. Part numbers for separate lock ring drive tool and wrench are listed in Tables 12 and 13 and shown in Tables 14 and 15. Consult aircraft handbooks for the required tool kit for other Rosan fittings.

14. PROCEDURES. Once fitting is seated, it shall not be rotated counterclockwise. Counterclockwise rotation could damage O-ring. Installation procedures for Rosan fittings are described in the following steps:

a. Place teflon bullet (Table 8), or one of similar size and material over smaller thread of the fitting as shown in Figure 4.

b. Submerge fitting, bullet, and O-ring in fluid to be used in working system or a lubricant compatible with system fluid.

c. Slide O-ring over bullet (Figure 5) and into groove of fitting. Make sure O-ring is not twisted and is properly seated in groove.

d. Lubricate internal surfaces of port cavity with fluid to be used in system or a compatible lubricant.

e. Insert smaller thread of fitting into port, turning clockwise by hand until fitting is seated.

f. Select wrench and drive tool or combination tool (determined by fitting size) from Tables 12 and 13.

g. Engage serrations of tool with external serrations of fitting lock ring (Figure 6).

h. Place torque wrench over wrench hex and apply torque equal to minimum value as specified in Tables 12 and 13, depending on size and type of fitting.

i. Check relationship of lock ring serrations with respect to broached serrations in port. If serrations match, as shown in Figure 7, proceed to step j. If serrations do not match, continue torquing fitting toward maximum values specified in Tables 12 and 13 until lock ring serrations match port serrations.

NOTE

Matching serrations will require 3 to 8 degrees of turning. Maximum torque value need not be reached if serrations are aligned before reaching 8 degrees.

j. Apply zinc chromate primer per TT-P-1757 with a brush or syringe to counterbore area of port. Do not allow zinc chromate to dry before installation of fitting is completed.

k. To drive lock ring, select combination tool or lock ring drive tool from Tables 12 and 13.

CAUTION

Any sudden increase in pressure or torque before bottoming may indicate lock ring serrations and port serrations are not aligned. If serrations are misaligned, remove lock ring from boss (Paragraph 17) and realign serrations as described in step i.

(1) When using a combination tool, place tool over fitting (Figure 8) and rotate tool until it touches lock ring. Use an open-end wrench or socket wrench on hexagon pad to turn tool clockwise until it bottoms on surface of port.

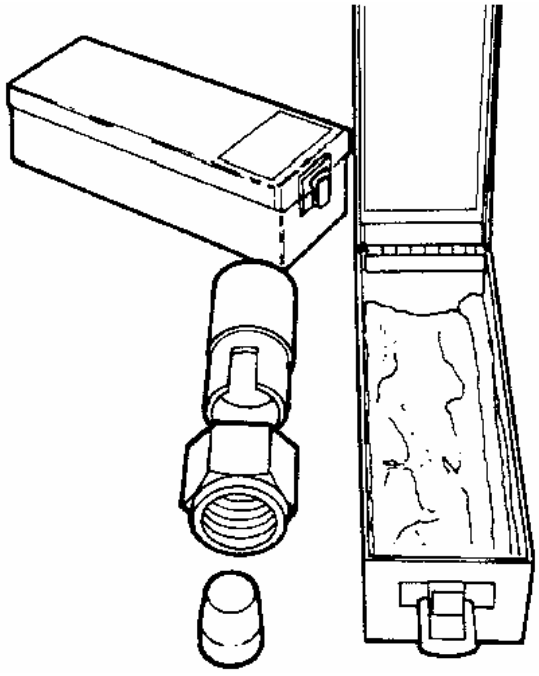

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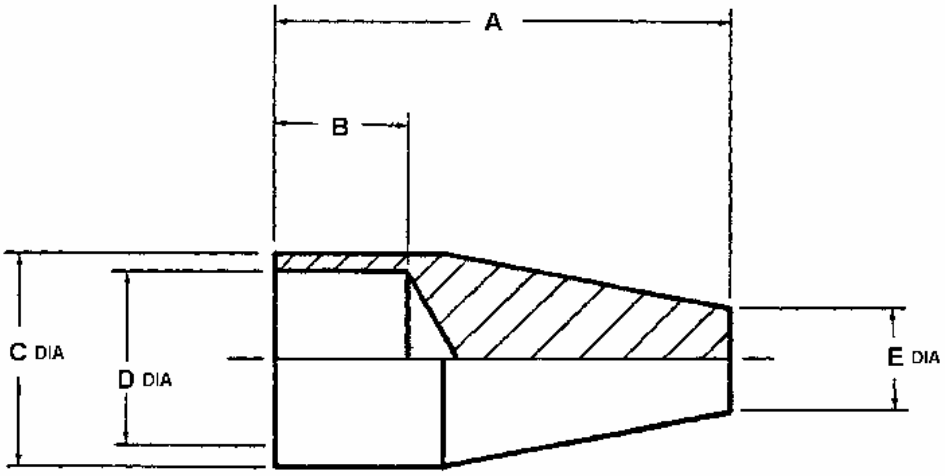
Figure 3. Typical Installation Tool Kit

Table 8. Bullet-Type O-Ring Installation Tool



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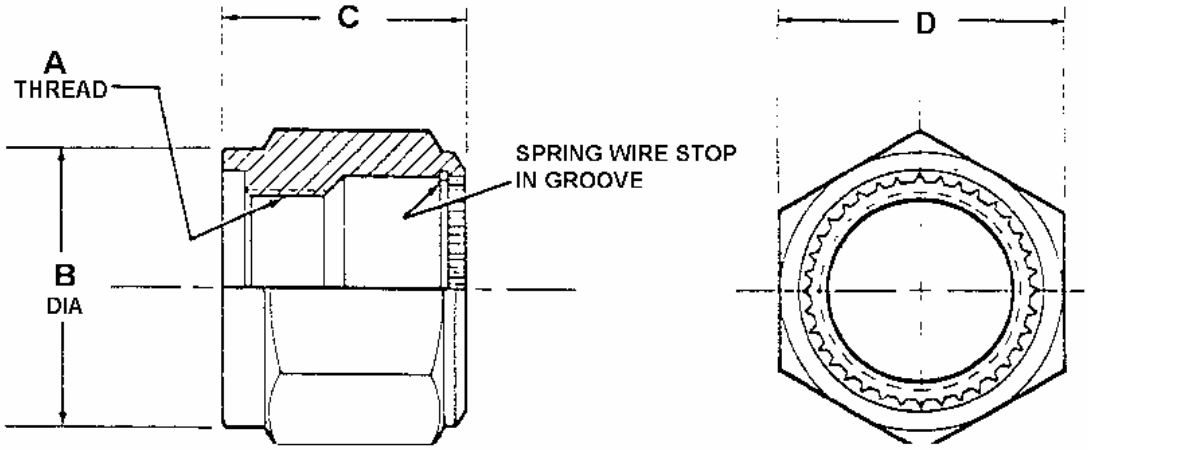
Tool No.	Port Size (Ref) (Note 1)	A ±.06	B +.05 -.01	C Dia. Max.	D Dia. Min.	E Dia. ±.040
ORT216	02	.71	.18	.283	.218	.100
ORT250	03	.79	.23	.322	.252	.130
ORT312	04	.83	.23	.385	.315	.190
ORT375	05	.86	.25	.445	.377	.250
ORT437	06	.90	.27	.505	.440	.310
ORT562	08	.98	.31	.635	.565	.435
ORT687	10	1.05	.34	.755	.690	.550
ORT812	12	1.12	.37	.885	.815	.670
ORT937	14	1.19	.40	1.010	.940	.795
ORT1125	16	1.25	.41	1.205	1.127	.920
ORT1312	20	1.82	.42	1.395	1.315	.920
ORT1625	24	1.94	.45	1.715	1.627	1.420
ORT2125	32	1.94	.58	2.215	2.127	1.975

Notes:
1. These sizes are dash number of standard rosan port PS10035.
2. Material: teflon or nylon.
3. All dimensions are in inches.

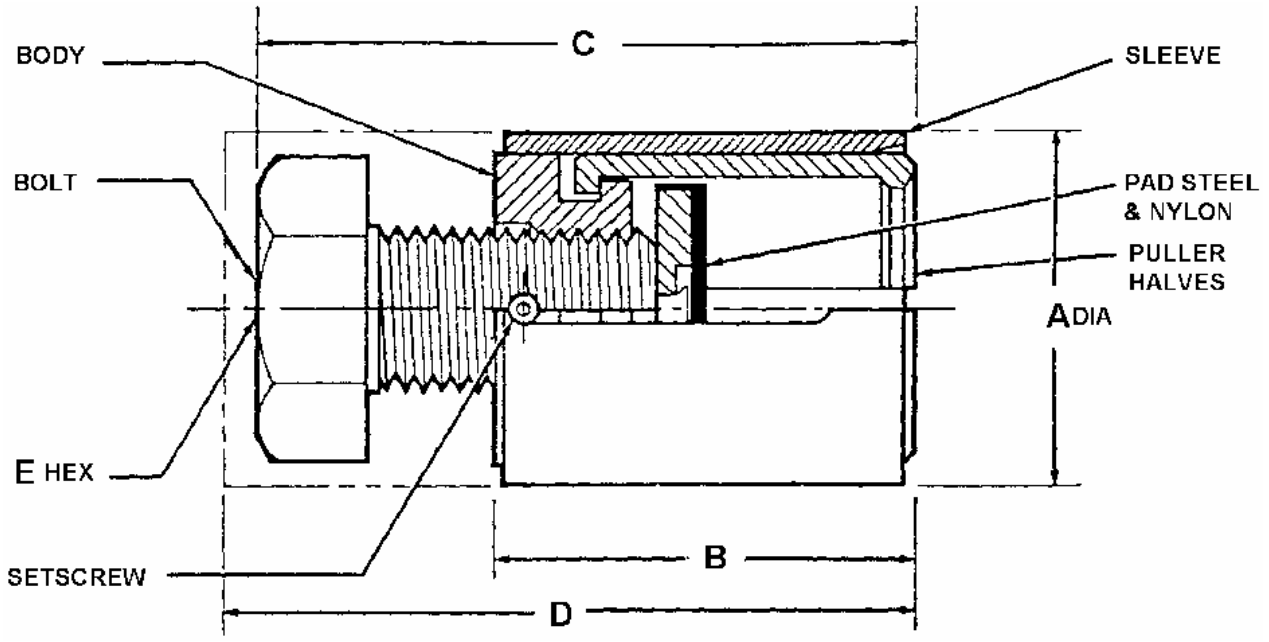
Table 9. Combination Tool, RF5000DW and RF9800DW Series



Combination Drive Tool And Wrench Tool No.	A MIL-S-8879	B Dia. ±.015	C ±.015	D Hex
RF5000DW Series				
RF5002DW	.3125-32UNJEF-3B	.680	1.000	.75
RF5003DW	.3750-28UNJS-3B	.750	1.000	.75
RF5004DW	.4375-24UNJS-3B	.800	1.000	.81
RF5005DW	.5000-24UNJS-3B	.900	1.000	.94
RF5006DW	.5625-20UNJS-3B	.980	1.120	1.00
RF5008DW	.7188-20UNJS-3B	1.100	1.120	1.12
RF5010DW	.8438-18UNJS-3B	1.320	1.250	1.38
RF5012DW	1.0000-16UNJ-3B	1.450	1.380	1.50
RF5014DW	1.1250-16UNJ-3B	1.580	1.450	1.62
RF5016DW	1.2500-14UNJS-3B	1.740	1.500	1.75
RF5020DW	1.5156-14UNJS-3B	2.070	1.500	2.12
RF5020TDW	1.5781-14UNJS-3B	2.070	1.500	2.12
RF5024DW	1.7812-14UNJS-3B	2.340	1.600	2.50
RF5024TDW	1.8438-14UNJS-3B	2.340	1.600	2.50
RF9800DW Series				
RF9802DW	.3125-24UNJF-3B	.680	.690	.75
RF9803DW	.3750-24UNJF-3B	.750	.720	.75
RF9804DW	.4375-20UNJF-3B	.800	1.250	.81
RF9805DW	.5000-20UNJF-3B	.900	1.300	.94
RF9806DW	.5625-18UNJF-3B	.980	1.370	1.00
RF9808DW	.750-16UNJF-3B	1.100	1.500	1.12
RF9810DW	.8750-14UNJF-3B	1.320	1.630	1.38
RF9812DW	1.0625-12UNJ-3B	1.450	1.790	1.50
RF9816DW	1.3125-12UNJ-3B	1.740	2.000	1.75
RF9820DW	1.625-12UNJ-3B	2.070	2.000	2.12
RF9824DW	1.875-12UNJ-3B	2.340	2.160	2.50
RF9832DW	2.500-12UNJ-3B	2.860	2.760	3.00

Notes: 1. RF9800DW Series can also be used on RF9900-13 series fittings.
2. All dimensions are in inches.

Table 10. Lock Ring Puller



Removal Tool No.	A Dia Max.	B Max.	C Max.	D Max.	E Hex Nom.
RF02LPDE	.812	2.24	3.91	3.98	.438
RF03LPDE	.812	2.24	3.91	3.98	.438
RF04LPDE	.812	2.24	3.91	3.98	.438
RF05LPDE	.937	2.41	4.31	4.31	.562
RF06LPDE	1.000	2.48	4.44	4.46	.562
RF08LPDE	1.125	2.63	4.73	4.72	.625
RF10LPDE	1.375	2.80	5.12	4.98	.938
RF12LPDE	1.500	2.93	5.47	5.26	1.125
RF14LPDE	1.685	3.19	5.82	5.68	1.125
RF16LPDE	1.812	3.34	6.18	6.01	1.312
RF20LPDE	2.250	3.60	6.72	6.52	1.312
RF24LPDE	2.500	4.02	7.35	7.18	1.312
RF32LPDE	3.125	4.81	8.83	8.76	1.312

Notes: 1. All dimensions are in inches.

Table 11. Installation Kits for Fittings RF9800 and RF9900 Series

Adapter Part No.	Kit Part No.
RF9804-13 RF9904-13	KM9RF9804
RF9806-13 RF9906-13	KM9RF9806
RF9808-13 RF9908-13	KM9RF9808
RF9810-13 RF9910-13	KM9RF9810
RF9812-13 RF9912-13	KM9RF9812
RF9816-13 RF9916-13	KM9RF9816
RF9820-13 RF9920-13	KM9RF9820
RF9824-13 RF9924-13	KM9RF9824

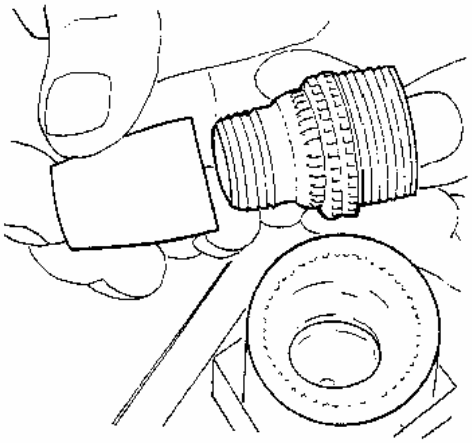


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Figure 4. O-Ring Installation Tool

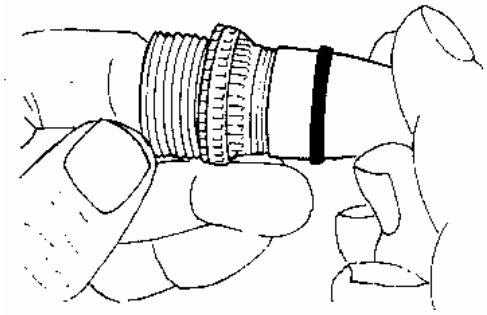

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Figure 5. O-Ring Installation

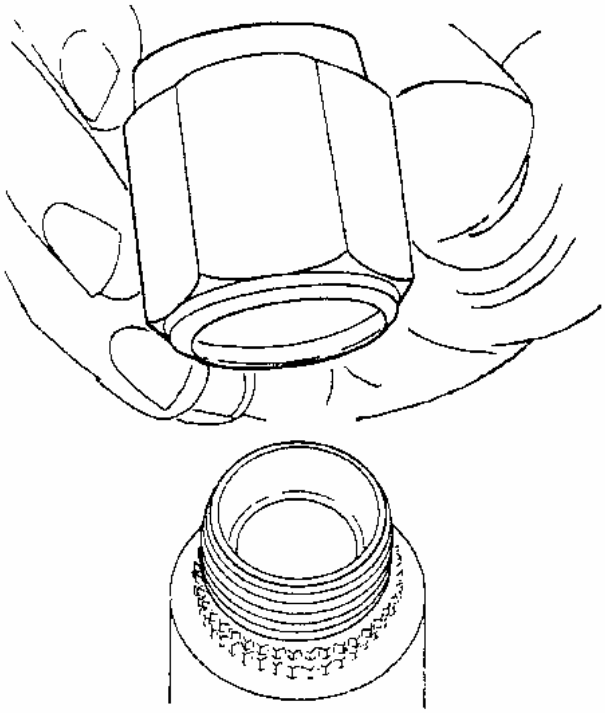

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Figure 6. Positioning Tool Over Fitting

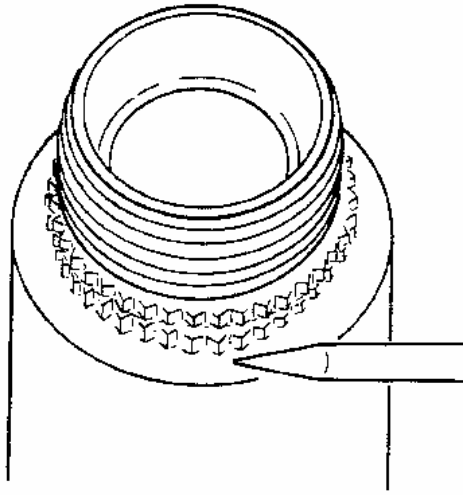

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Figure 7. Properly Matched Serrations

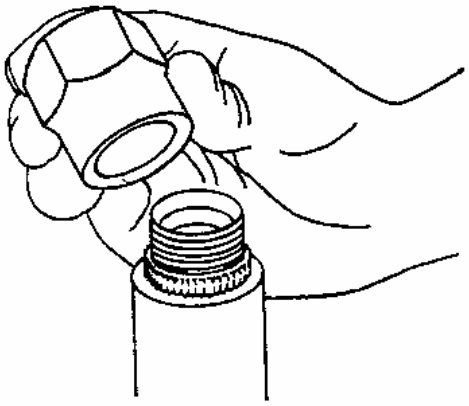

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Figure 8. Lock Ring Installation

Table 12. Fitting RF9800 and RF9900 Series Tooling and Installation Torque Values

Tube Size (Note 4)	Basic Fitting Number (Ref)	Wrench	Lock Ring Drive Tool (Note 1)	Combination Tool (Note 2)	Installation Torque (Inch Pounds)		Lock Ring Puller Assy. Tool No. (Note 3)
					Min.	Max.	
.125	RF9802 & RF9902	RF6902W	RF9802DEK	RF9802DW	16	21	RF02LPDE
.188	RF9803 & RF9903	RF6903W	RF9803DEK	RF9803DW	38	45	RF03LPDE
.250	RF9804 & RF9904	RF6904W	RF9804DEK	RF9804DW	60	100	RF04LPDE
.312	RF9805 & RF9905	RF6905W	RF9805DEK	RF9805DW	100	120	RF05LPDE
.375	RF9806 & RF9906	RF6906W	RF9806DEK	RF9806DW	180	245	RF06LPDE
.500	RF9808 & RF9908	RF6908W	RF9808DEK	RF9808DW	430	510	RF08LPDE
.625	RF9810 & RF9910	RF6910W	RF9810DEK	RF9810DW	600	680	RF10LPDE
.750	RF9812 & RF9912	RF6912W	RF9812DEK	RF9812DW	855	945	RF12LPDE
1.000	RF9816 & RF9916	RF6916W	RF9816DEK	RF9816DW	1140	1260	RF16LPDE
1.250	RF9820 & RF9920	RF6920W	RF9820DEK	RF9820DW	1520	1680	RF20LPDE
1.500	RF9824 & RF9924	RF6924W	RF9824DEK	RF9824DW	1900	2100	RF24LPDE
2.000	RF9832 & RF9932	RF6932W	RF9832DEK	RF9832DW	2660	2940	RF32LPDE

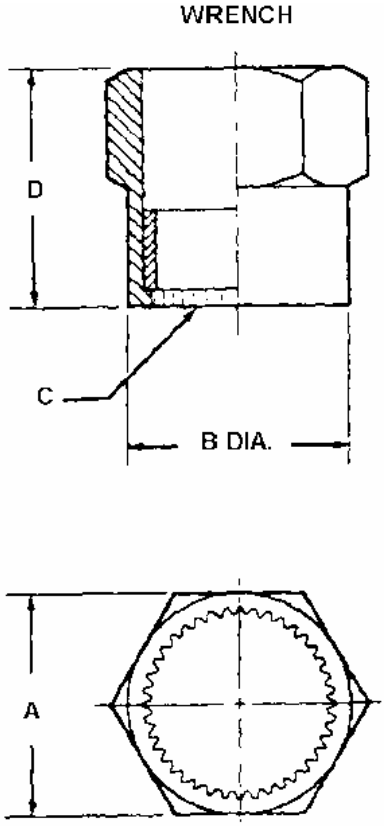
Notes:
1. Lock ring drive tool RF9800DEK supersedes RF9800DE. Tool RF9800DE may be used on basic adapters RF9800 and RF9900 but not on reducers, restrictors, filters or quick disconnects.
2. The combination wrench and lock ring drive tool RF9800DW series may be used in place of the wrench & lock ring drive tool shown for basic adapters RF9800 & RF9900 but not on reducers, restrictors, filters or quick disconnects.
3. Lock ring puller assembly RF ( ) LPDE supersedes RF9800LPD and will remove all basic adapters, reducers, restrictors, filters, and quick disconnects.
4. Tube sizes are in inches.

Table 13. Fitting RF5000 Series Tooling and Installation Torque Values

Tube Size (Note 3)	Basic Fitting Number (Ref)	Wrench	Lock Ring Drive Tool (Note 1)	Combination Tool (Note 1)	Installation Torque (Inch Pounds)		Lock Ring Puller Assy. Tool No. 2
					Min.	Max.	
.125	RF5002	RF6902W	RF9802DEK	RF5002DW			RF02LPDE
.188	RF5003	RF6903W	RF9803DEK	RF5003DW			RF03LPDE
.250	RF5004	RF6904W	RF9804DEK	RF5004DW	50	65	RF04LPDE
.312	RF5005	RF6905W	RF9805DEK	RF5005DW	100	125	RF05LPDE
.375	RF5006	RF6906W	RF9806DEK	RF5006DW	140	200	RF06LPDE
.500	RF5008	RF6908W	RF9808DEK	RF5008DW	270	375	RF08LPDE
.625	RF5010	RF6910W	RF9810DEK	RF5010DW	620	700	RF10LPDE
.750	RF5012	RF6912W	RF9812DEK	RF5012DW	855	945	RF12LPDE
.875	RF5014	RF6914W	RF9814DEK	RF5014DW	995	1105	RF14LPDE
1.000	RF5016	RF6916W	RF9816DEK	RF5016DW	1140	1260	RF16LPDE
1.250	RF5020	RF6920W	RF9820DEK	RF5020DW	1520	1680	RF20LPDE
1.250	RF5020T	RF6920W	RF9820DEK	RF5020TDW	1520	1680	RF20LPDE
1.500	RF5024	RF6924W	RF9824DEK	RF5024DW	1900	2100	RF24LPDE
1.500	RF5024T	RF6924W	RF9824DEK	RF5024TDW	1900	2100	RF24LPDE

Notes:
1. The combination wrench and lock ring drive tool RF5000DW series may be used in place of the wrench & lock ring drive tool shown for basic adapters RF5000 series but not on reducers, restrictors, filters or quick disconnects.
2. Lock ring puller assembly RF ( ) LPDE supersedes RF5000LPD and will remove all basic adapters, reducers, restrictors, filters and quick disconnects.
3. Tube sizes are in inches.

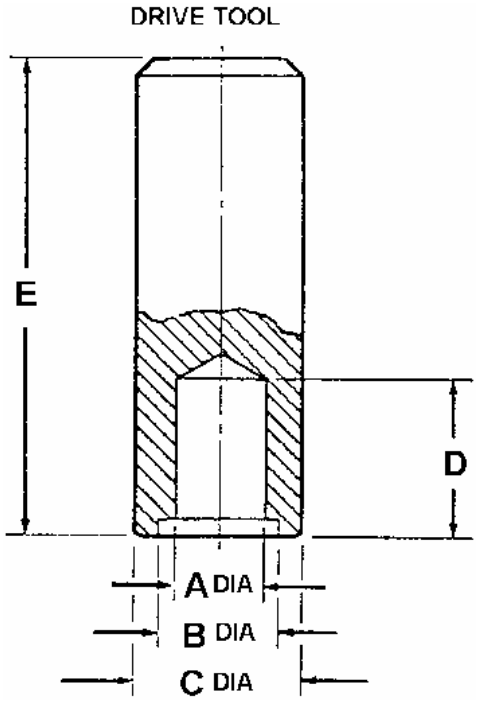
Table 14. Wrench Part Numbers



Wrench Part No.	A Hex	B Dia. Max.	C No. of Teeth	D ±.03
RF6902W	.56	.572	24	1.50
RF6903W	.69	.698	26	1.50
RF6904W	.75	.760	30	1.50
RF6905W	.75	.760	36	1.50
RF6906W	.88	.885	36	1.50
RF6908W	1.00	1.010	40	1.50
RF6910W	1.19	1.198	38	1.50
RF6912W	1.38	1.385	40	1.50
RF6914W	1.62	1.635	50	1.50
RF6916W	1.75	1.760	36	1.50
RF6920W	2.00	2.010	56	1.50
RF6924W	2.25	2.260	81	1.50
RF6932W	2.88	2.885	102	1.75

Notes: 1. All dimensions are in inches.

Table 15. Drive Tool Part Numbers



Drive Tool No.	A Dia. +.007 -.001	B Dia. +.006 -.001	C Dia. +.010 -.020	D +.1 -.0	E ±.05
RF9802DEK	.324	.412	.562	2.2	3.00
RF9803DEK	.386	.481	.625	2.2	3.00
RF9804DEK	.442	.527	.750	2.2	3.00
RF9805DEK	.537	.637	.875	2.2	3.00
RF9806DEK	.595	.712	1.000	2.2	3.00
RF9808DEK	.755	.827	1.125	2.2	3.00
RF9810DEK	.880	1.053	1.375	2.2	3.00
RF9812DEK	1.067	1.183	1.500	2.2	3.00
RF9814DEK	1.218	1.354	1.750	2.2	3.00
RF9816DEK	1.327	1.469	1.875	2.2	3.00
RF9820DEK	1.630	1.795	2.125	2.2	3.00
RF9824DEK	1.880	2.045	2.375	2.2	3.00
RF9832DEK	2.505	2.561	2.875	3.2	4.00

Notes: 1. Lock Ring Drive Tool RF9800DEK supersedes RF9800DE and RF5000-02D.
2. All dimensions are in inches.

(2) When using a lock ring drive-tool, position counterbored end over lock ring. Apply a force to drive-tool with a hammer or an arbor press. Drive tool until face of tool touches surface of port boss.

l. Remove excess chromate that has flowed onto port surface.

15. REMOVAL.

16. To remove a Rosan fitting, lock ring must be removed first by using a lock ring puller (Table 10). Choose correct size removal tool specified in Tables 12 and 13.

17. PROCEDURES. Removal procedures for Rosan fittings are described in the following steps.

a. Select lock ring puller from Tables 12 and 13 by fitting size.

b. Spread jaw halves while pulling sleeve from assembly until pin bottoms in sleeve groove (Figure 9).

c. Holding puller halves apart, place tool over protruding fitting so nylon pad rests on top surface of fitting.

d. Release puller halves and position jaw pulling-flange in circular lock ring groove. Adjust jaws by turning bolt head up or down.

e. Slide sleeve over jaws. If resistance is noted when attempting to slide sleeve over jaws, check that pulling flange has engaged the circular lock ring groove.

f. Use an open-end wrench or socket wrench; turn bolt clockwise while holding sleeve with other hand until lock ring is pulled out of port counterbore (Figure 10).

g. When extended lock ring serrations are clear of port surface, remove tool from fitting by loosening bolt and lifting sleeve to free puller jaws.

h. Select wrench from Table 12 or 13 by fitting size.

i. Engage wrench serrations with lock ring serrations. Use an open-end wrench or socket wrench to turn fitting counterclockwise to disengage fitting from port.

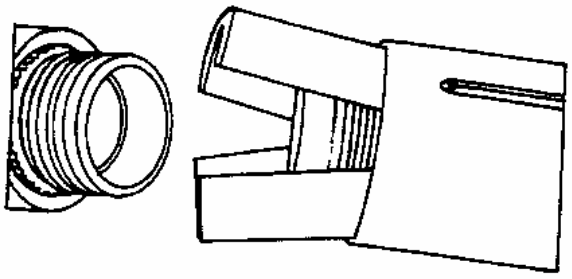


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Figure 9. Lock Ring Puller Tool

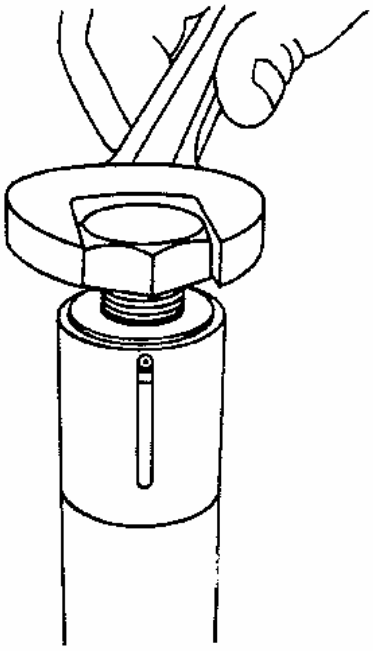

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Figure 10. Removing Lock Ring

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION AND MAINTENANCE

DYNATUBE FITTINGS

Reference Material

Tubing, Tube Assemblies, and Fittings, Description WP008 00
Tube Assemblies, Fabrication WP009 00

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Record of Applicable Technical Directives

None

1. GENERAL.

2. This section provides descriptions and maintenance instructions for Dynatube fittings used on some Naval aircraft and Resistoflex hand tools used to install these fittings. Dynatube fittings can also be connected to rigid tubing by welding, but internal mechanical swaging with Resistoflex hand tools is the authorized method for Navy personnel. Welded and mechanically attached Dynatube fittings are shown in Figure 1.

3. Dynatube fittings consist of a threaded male connector, a female shoulder with a machined beam, and a nut (Figure 2). Compared to the five components in a standard MS fitting, the three components in a Dynatube fitting are smaller, lighter, and have fewer potential leak paths (Figure 3). Dynatube fittings have solid film lubricant on all sliding surfaces which allows the fittings to be assembled without additional lubricant. Figure 4 shows various Dynatube fitting configurations.

4. DESCRIPTION.

5. The dynatube fitting is an all-metallic tube fitting (Figure 2) which incorporates a low angle, integral dynamic diaphragm sealing element (beam). The inner edge of the beam forms the initial seal upon contact with the mating sealing surface. As additional torque is applied, the beam deflects to its full extent, assuming the same angle as the mating surface. Further tightening to a torque within the recommended range completes the assembly, imposing thrust loads through the solid outer rim of the dynamic sealing element.

6. RESISTOFLEX SWAGING TOOLS.

Materials Required

Specification or Part Number	Nomenclature
MIL-D-16791	Detergent

7. The tools required to repair existing tube assemblies or fabricate new assemblies are supplied in a kit which is contained in one or more lightweight carrying cases. A typical case of tests is shown in Figure 5. A brief description of the most commonly used tools is given in Paragraphs 8 and 9. Each case contains complete instructions for repair and tube assembly fabrication. The kits support a particular aircraft, depending on the tube size, material, and tube wall thickness specified for original equipment or repair (Table 1).

8. TUBE EXPANDERS. Tube expanders are precision swaging tools used for expanding tubing into serrations of Dynatube fitting sockets. Tube expanders are set to expand tubing to a specific diameter and shall be used only with the tube and wall thickness stated on the tool identification band. Part number and description are identified on a stainless steel band fastened to each expander tool. In addition to letter designation, expanders are color coded for intended tube material (Figure 6).

NOTE

Expander tool for -03 sized tubing is slightly different (Paragraph 36). It has a non-rotary mandrel.

9. HOLDING FIXTURE DIES. Holding fixture dies support and position Dynatube fittings during swaging. Holding fixture dies have a nest which conforms to the shape and size of the fitting to be used. A male and female set of dies is provided for each basic tube diameter size which corresponds with male or female Dynatube fittings (Figure 7). Female dies will also accommodate female reducer fittings.

10. Holding Fixture Collars. Holding fixture collars are used to clamp holding fixture dies shut during swaging. Three sizes are provided to fit the six sizes of dies used (Figure 8).

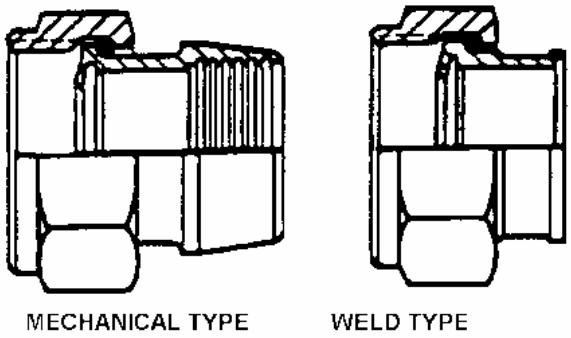
11. PRODUCTION SWAGING MACHINE. The production swaging machine (Figure 9) is economical for attaching Dynatube fittings in volume. The machine setup is limited to three quickchange components (die set, expander and bushing) which are provided for each tube size. Two machine models are available, each having the capability to attach Dynatube fittings to titanium, stainless steel and aluminum tubing.

12. TOOL MAINTENANCE. Tool maintenance procedures are provided as a guide for servicing those tools that are subject to wear during use. Where practical, methods of adjustment are also given to measure accuracy of these tools.

13. Tube Expanders. For optimum service life, tube expanders shall be cleaned and lubricated regularly as follows:

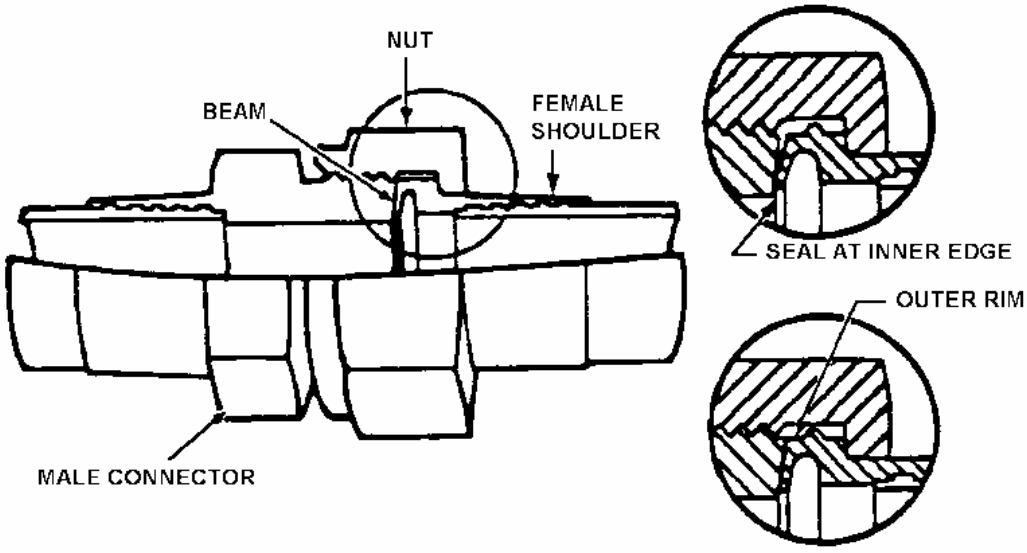
Non-Ionic Detergent, MIL-D-16791 **6**

a. Immerse rollers and mandrel in MIL-D-16791.



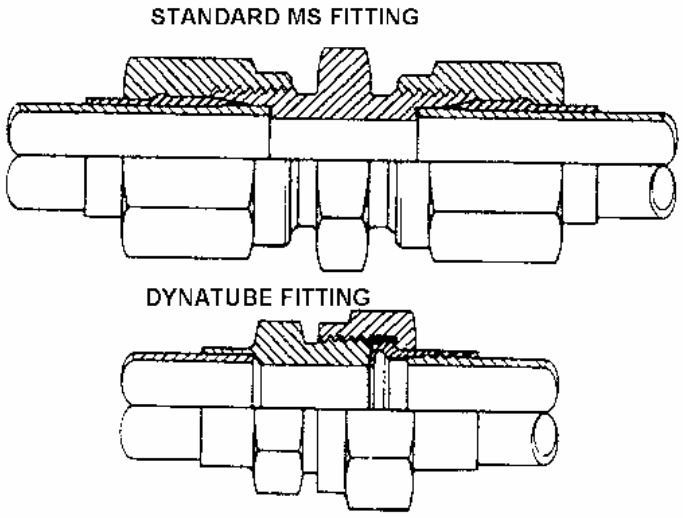
013001

Figure 1. Typical Welded and Mechanically Attached Dynatube Fittings



013002

Figure 2. Dynatube Fitting



013003

Figure 3. Dynatube Versus MS Fitting

NOTE

Keep tube expander body away from degreaser to avoid washing lubricant off internal bearings.

b. Blow-dry tube expander, using a low-pressure air hose.

CAUTION

Use only lubricant provided in tool kit. Other lubricants may damage mandrel and rollers.

c. Lubricate tube expander with lubricant provided in tool kit (Figure 5).

14. Tube Expander Setting. The tube expander setting is the diameter over rollers when the mandrel is in full expansion position. The set value is a function of the tube dimensions and material properties and is called the C-3 value. The expansion value shown on the expander identification band is the expanded internal diameter of swaged tube. Tube expander setting C-3 is always greater than this value to account for elastic behavior of the tube and specified dimensional tolerances (Table 2).

15. C-3 Value. The C-3 value of the tube expander setting can be measured by a Vee Anvil micrometer or a set ring gage (Figure 5). Set ring gages measure tube expanders of all sizes, whereas Vee Anvil micrometers are limited to tube expanders that swage tubes of 1-inch diameter or less. This manual provides instructions for measuring tube expander setting with set ring gages only. To measure tube expander setting with a set ring gage proceed as follows:

NOTE

Set ring gage is used on AV-8B aircraft.

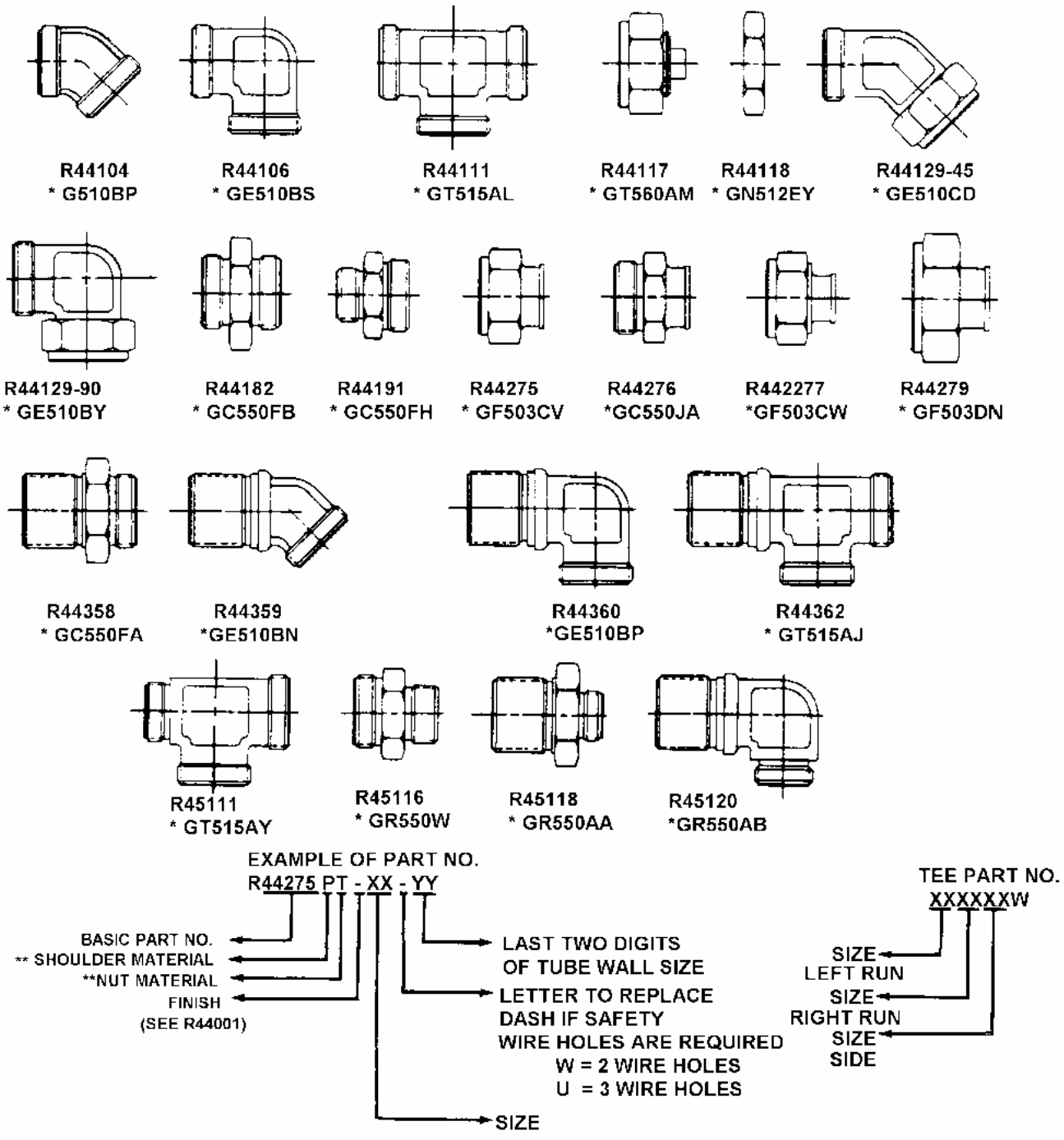
a. Select set ring gage (Figure 5).

b. Hold tube expander in one hand and set ring gage in other hand. With mandrel in pullback position, insert cage and expander rollers into set ring gage.

c. Depress mandrel until it contacts stop collar. If setting is correct, roller fit will be smooth, yet firm.

Table 1. Tool Kits for Specific Aircraft

Aircraft	Tool Kit Part No.
F-14	R27500GT
F-18	R27500MN
AV-8B	R27500MH

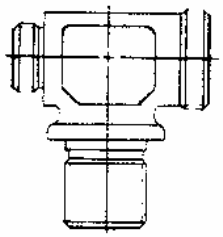


NOTES:

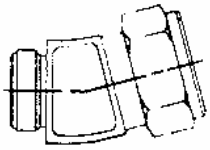
1. *REFERENCE GRUMMAN PART NO.
2. ABOVE FITTINGS ARE USE ON F-14 AIRCRAFT.
3. **ONE LETTER WHEN BOTH COMPONENTS ARE SAME MATERIAL.

01300401

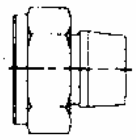
Figure 4. Dynatube Fittings (Sheet 1 of 5)



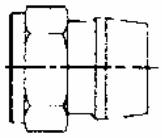
R45121
*GT515BC



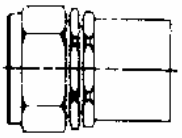
R45129-15
*GT550AC



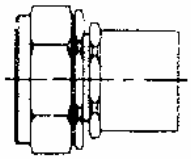
MR54027
*GF503BK



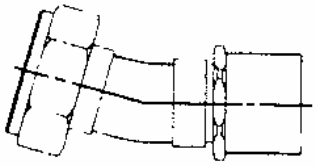
MR54040
*GF503BH



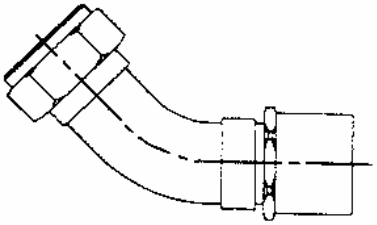
R4400CCT-XX-0 0
*GF503BS



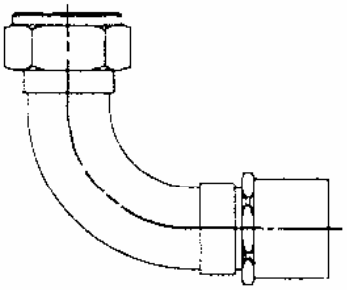
R4400CCT -XX-00
*GF503BR
EXPANDER



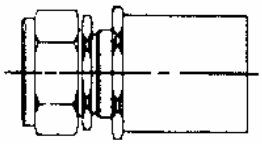
R7433CCT -XX-15
*GE510DY
EXPANDER



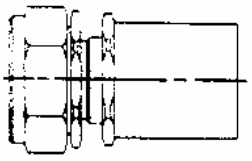
R7433CCT -XX-45
*GE510CH



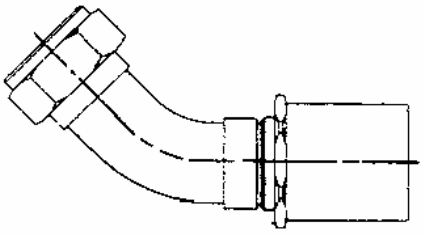
R7433CCT -XX-90
*GE510CM



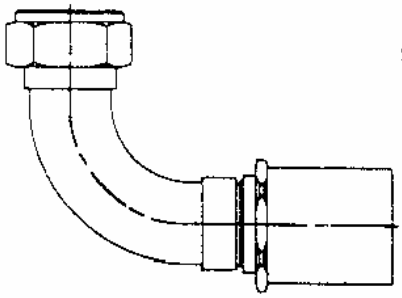
A24400CCT -XX-00
*GE503BN



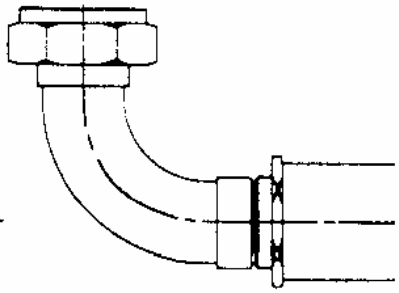
A24400CT -XX-00
*GE503BP
EXPANDER



A27433CCT -XX-45
*G3510CL



A27433CCT -XX-90
*GE510CF



A27433CCT -XX-90
*GE510CK
EXPANDER

EXAMPLE OF PART NO.
A24400CCTW - XX - 00

BASIC PART NO.
ADD LETTER IF SAFETY
WIRE HOLES ARE REQUIRED
W = 2 WIRE HOLES
U = 3 WIRE HOLES

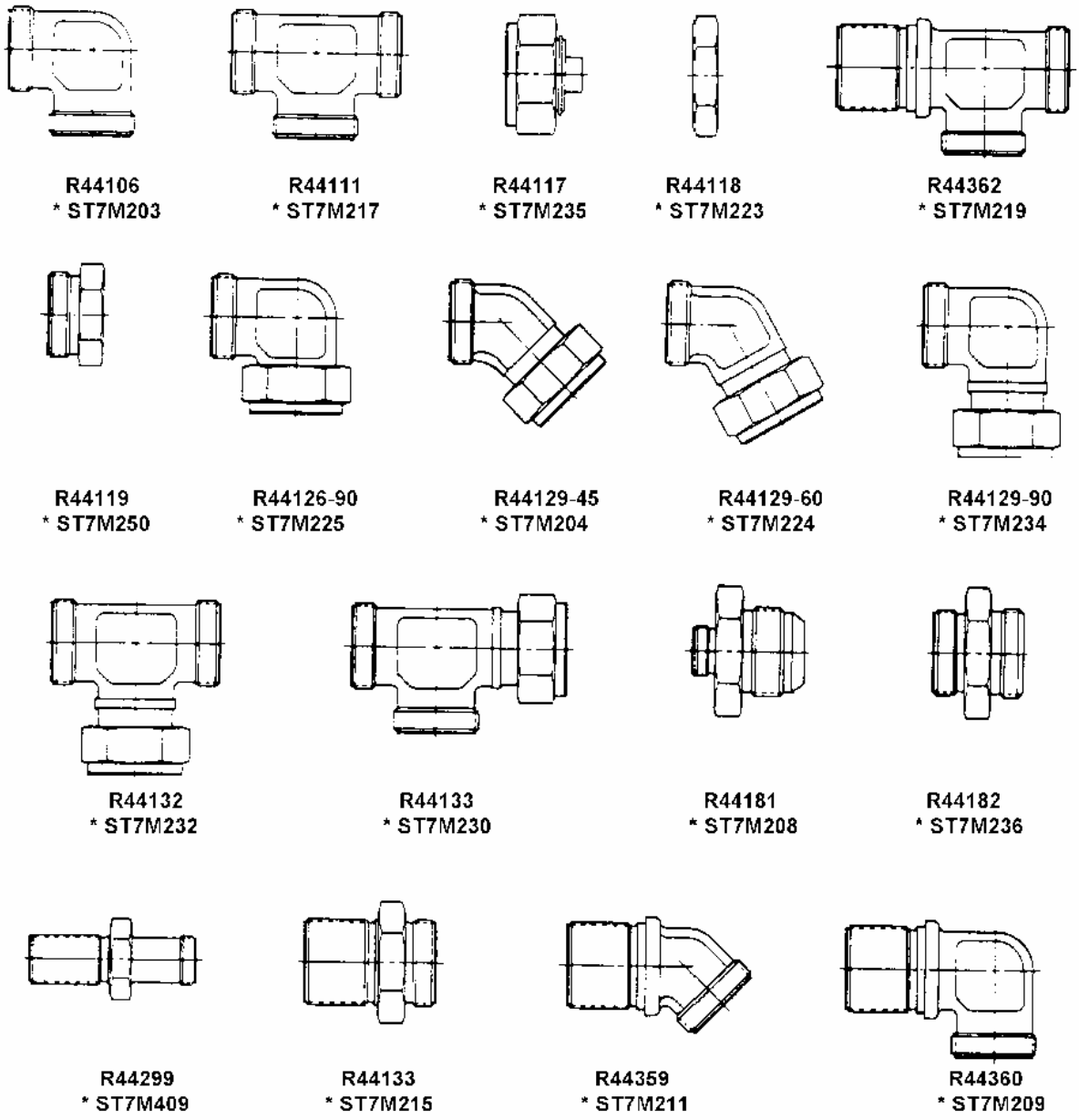
STRAIGHT FITTING
SIZE (HOSE SIZE FIRST)

NOTE:

1. REFERENCE GRUMMAN PART NO.

01300402

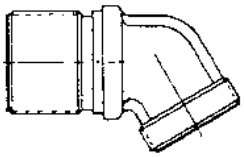
Figure 4. Dynatube Fittings (Sheet 2)



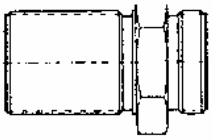
NOTE:
***REFERENCE CUSTOMER PART NO.**

01300403

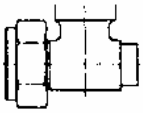
Figure 4. Dynatube Fittings (Sheet 3)



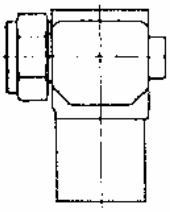
R44365
*ST7M210



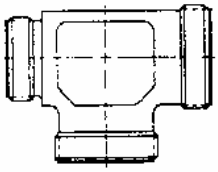
R44381
*ST7M229



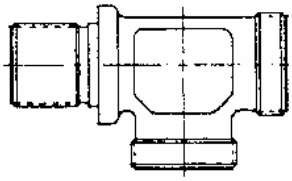
R44406
*74J548018-101



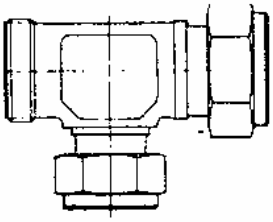
R44407
*74J548018-103



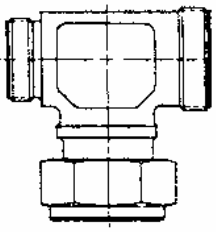
R45111
*ST7M220



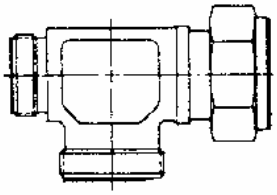
R45122
*ST7M222



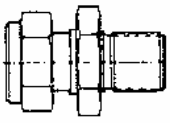
R45130
*ST7M246



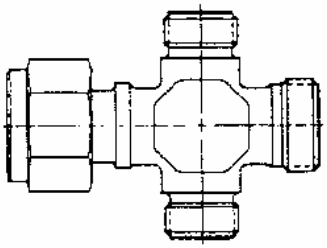
R45132
*ST7M233



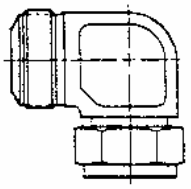
R45133
*ST7M231



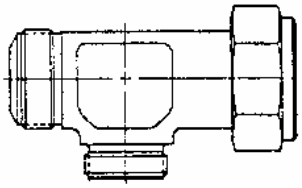
R45145
*ST7M449



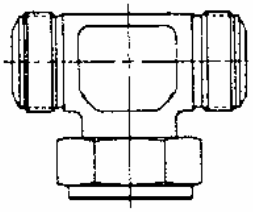
R45137
*ST7M462



R46126-90
*74J698002-101



R46142
*74J698003-101



R46143
*74J698008-101

EXAMPLE OF PART NO.
SIZE TO SIZE & ELBOWS:

BASIC PART NO., MATERIAL, FINISH & SAFETY WIRE HOLES SAME PATTERN FOR ALL PART NUMBERS.

TEES

R45130T- XXXXXXW
- SIZE
- LEFT RUN SIZE
- RIGHT RUN SIZE, SIDE

CROSSES

R45137T- XXXXXXXXW
- SIZE
- LEFT RUN SIZE
- RIGHT RUN SIZE
- TOP SIDE SIZE
- BOTTOM SIDE

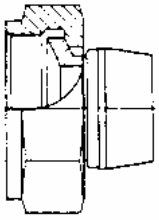
R46XXXT- XXW
- SELF- ALIGNING FITTING

NOTE:

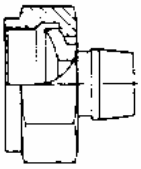
*REFERENCE CUSTOMER PART NO.

01300404

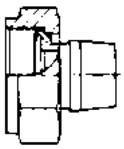
Figure 4. Dynatube Fittings (Sheet 4)



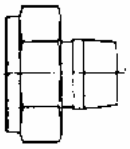
MR46000
* 74J8004-101



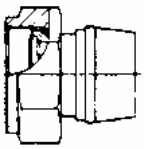
MR446027
*74J698004-103



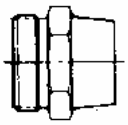
MR54027
* 7M525



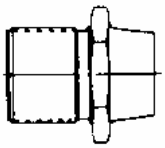
MR54027
* 74J698022-101



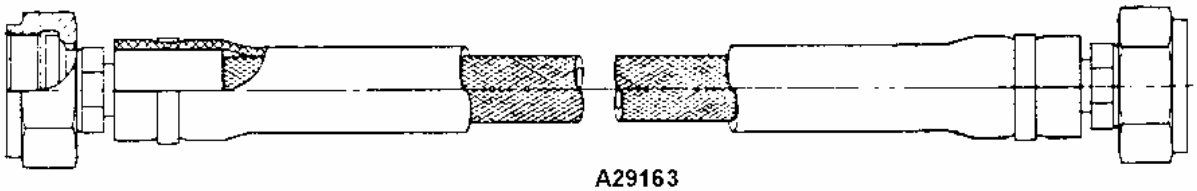
MR54040-04 THRU 12 & 21
MR54042-16
* 7M523



MR54100-04 THRU 12 & 21
MR54200-16
* 7M524



MR54124
* 7M526



A29163
*74J698023-101

EXAMPLE OR PART NO.

SIZE TO SIZE

BASIC PART NO., MATERIAL, FINISH & SAFETY WIRE HOLES SAME PATTERN FOR ALL PART NUMBERS.

JUMP SIZE
MR54027T-XXXXW
- SIZE, TUBE END
- SIZE, SEAL END

HOSE ASSEMBLY
A29164-XXXX FITTING
- SIZE, SEAL END
- SIZE, HOSE

MR46XXXT
- SELF-ALIGNING FITTING

NOTE:

* REFERENCE CUSTOMER PART NO.

01300405

Figure 4. Dynatube Fittings (Sheet 5)

NOTE

There shall be no play as evidenced by rocking or side motion. Dimensions of ring bore automatically account for allowable tolerance in C-3 value of tube expander.

16. Adjusting Tube Expander Setting. The C-3 setting is adjustable within a limited range of the design value. The C-3 value is determined by the mandrel travel which is defined by the position of the stop collar (Table 2). To adjust tube expander setting, proceed as follows:

a. Place stop collar (Figure 10) in vise and loosen locknut by turning it away from stop collar.

b. Remove tube expander from vise.

CAUTION

Adjusting tube expander setting to values in excess of C-3 + 0.001 could lead to premature tube expander tool failure.

c. Adjust tube expander setting to C-3 value (Table 2) by turning stop collar towards locknut to increase C-3 value or away from locknut to decrease C-3 value.

d. Measure new C-3 value with a Vee Anvil micrometer or as described in the paragraph above.

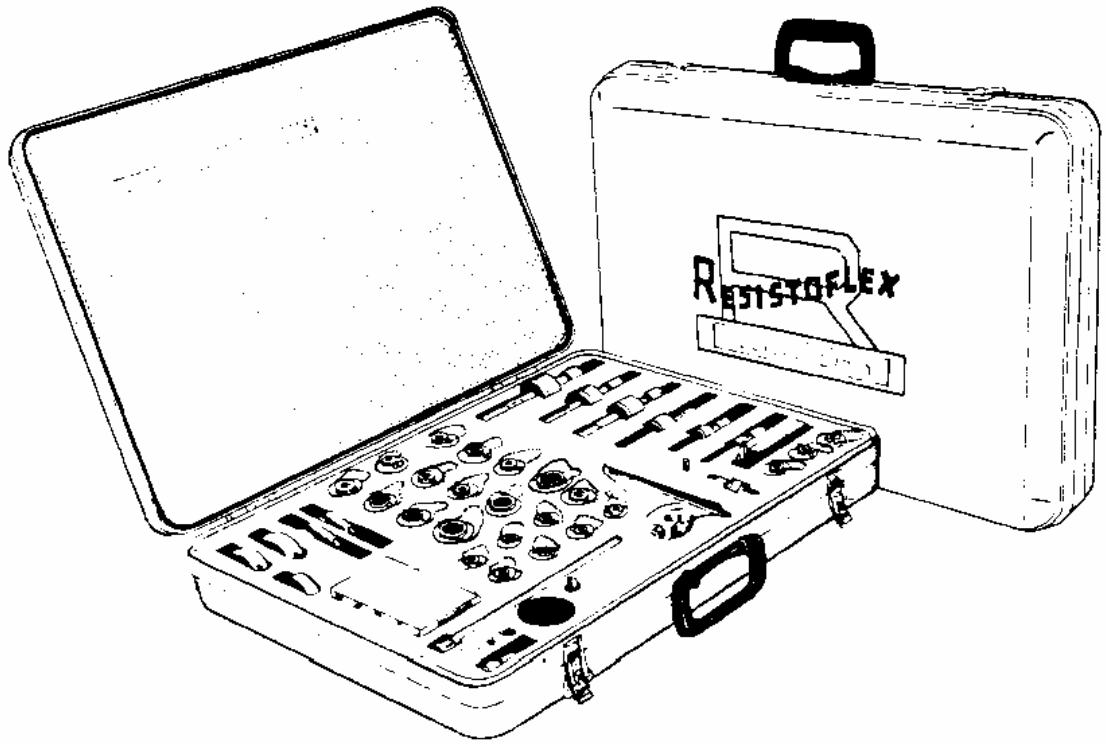
e. When desired setting is reached, place stop collar in vise and tighten locknut against stop collar.

f. Remeasure C-3 value.

17. Replacing Tube Expander Mandrels and Rollers. Mandrels and rollers (Figure 10) are two of the tube expander components requiring service due to normal usage. To inspect or replace mandrels or rollers, disassemble tube expander as follows:

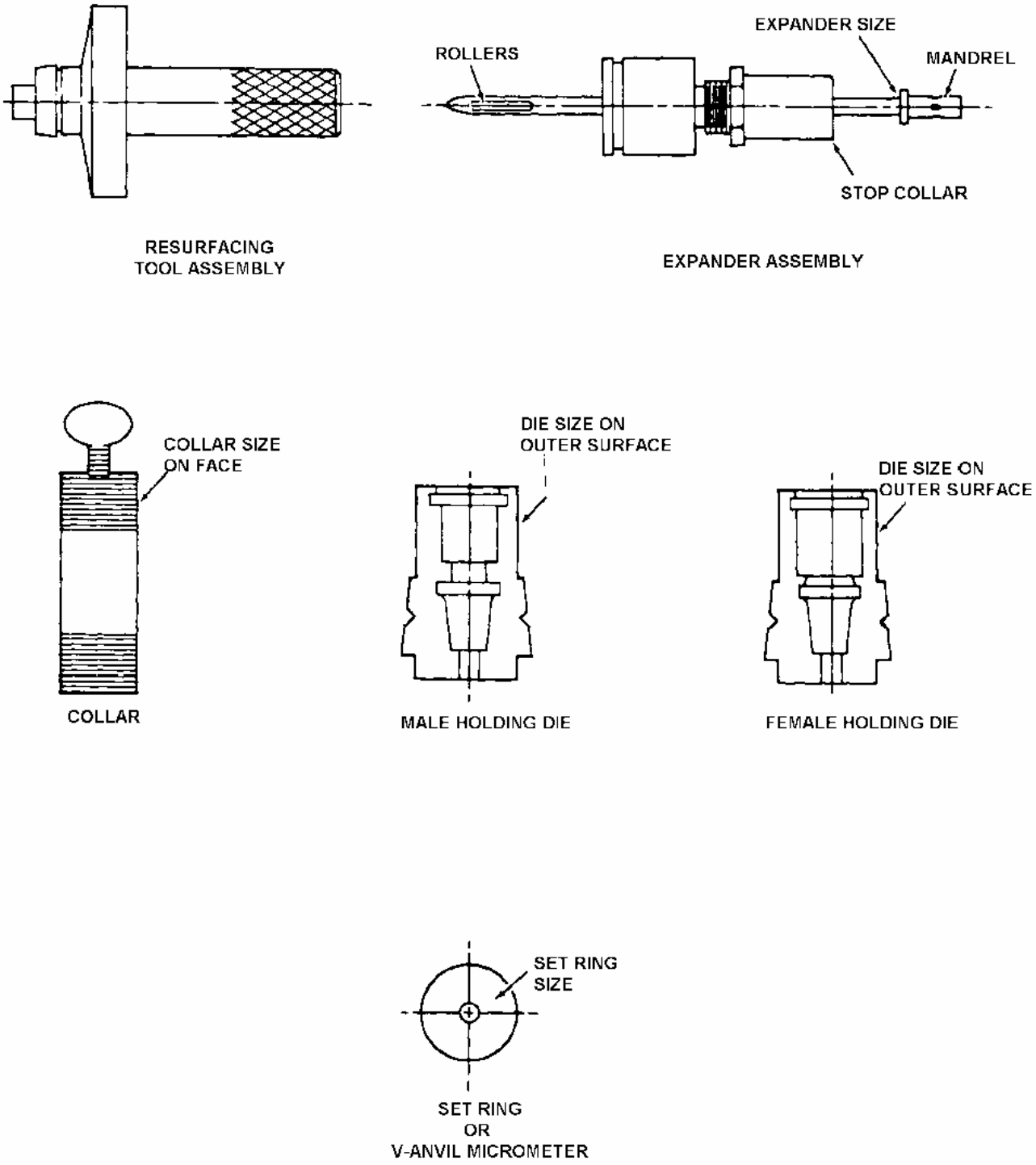
a. Clamp stop collar in vise and loosen locknut by turning it away from stop collar.

b. Remove tube expander from vise and turn stop collar out until threads disengage from barrel threads.



01300501

Figure 5. Typical Field Installation and Repair Tool Kit (Sheet 1 of 4)



01300502

Figure 5. Typical Field Installation and Repair Tool Kit (Sheet 2)

CASE NO.	TUBE AND WALL SIZE	EXPANDER & TUBE MATERIAL		COLLARS	FEMALE DIES	MALE DIES	RESURFACING TOOLS (NOTE 1)
		PART NO.	MATERIAL				
R24837GT-4-1	.188 X .020	R24106B-020	304 SS	R24837-1-06	RF26826-2B-03	RM26826-2B-04	R24837-6-03
	.250 X .020	R5170G-04020S	304 SS		RF2826-2-04	RM26826-2-04	R24837-6-04
	.375 X .028	R5170G-06028 USE FOR .375 X .028 AND .375 X.028	TITANIUM 304 SS		RF268-2-06	RM26826-2-06	R24837-6-06
	.500 X .036	R5170G-08036 USE FOR .500 X .036 AND .500 X .035	TITANIUM 304 SS	R24837-1-12	RF26826-2-08	RM26826-2-08	R24837-6-08
	.625 X .044 .625 X .049	R5170G-10044 R5170G-10049S	Ti 3Al-2.5V 304 SS		RF26826-2-10	RM26826-2-10	R24837-6-10
	.750 X .054 .750 X .058	R5170G-12054 R5170G-12058S	Ti 3Al-2.5V 304 SS		RF26826-2-12	RM26826-2-12	R24837-6-12
	1.000 X .065 1.000 X .073	R5170G-16065S R5170G-16073	304 SS Ti 3Al-2.5V	R26826-1-16	RF26826-2-16	RM26826-2-16	R24837-6-16

MISCELLANEOUS ITEMS		HAND TOOLS	
PART NO.	TOOL	PART NO.	TOOL
R24837-6-2-20	LOCK SLEEVE, RESURFACING TOOL 1.250	R24837-10-1	RATCHET WRENCH
R24837-6-2-24	LOCK SLEEVE, RESURFACING TOOL 1.500	R24837-10-2	WRENCH EXTENSION, 10.625
R24837-7-1	EMERY DISCS	R24837-10-4	ADAPTER, .375 X .250
R24837-8-3	LUBRICANT	R24837-11-3	PUNCH, .188 SIZE
R24837-98	LUBE REPAIR KIT	R24837-15	TUBE CLAMP
R24837-14GT	INSTRUCTION LITERATURE	R24837-16-32	TUBE CUTTER
R24837-16-07	INSIDE DIAMETER GAGE, .150 - .950		
R24837-16-10	INSIDE DIAMETER GAGE, .188 SIZE TUBE		
R24837-16-40	TUBE MARKING GAGE		
R5170MDZ	SET RING		
R24837-16-20	V-ANVIL MICROMETER		
R24837-6-3-20	CUP, RESURFACING TOOL 1.250		
R24837-6-3-24	CUP, RESURFACING TOOL 1.500		

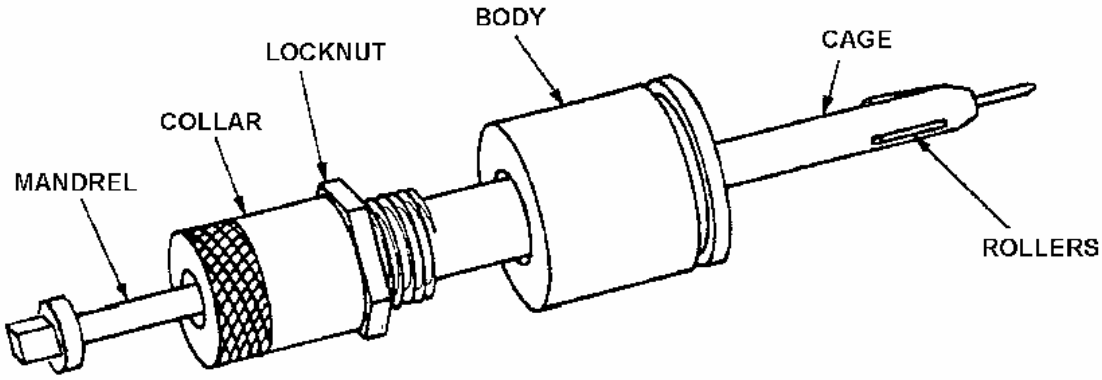
Figure 5. Typical Field Installation and Repair Tool Kit (Sheet 3)

THE TOOLING BELOW IS NOT INCLUDED IN THE BASIC TOOL SET.
ALL ITEMS MAY BE ORDERED INDIVIDUALLY OR IN KITS AS SPECIFIED (NOTES 2 AND 3)

SPARE PARTS FOR EXPANDERS KIT R27501GT-11		
MANDRELS	**ROLLERS**	**EXPANDER CAGE**
R24106-1-020-1	N/A	N/A
R5166M-04020	R5166R-04R-3 (3 SETS)	R5170C-04020-3
R5166M-06028	R5166R-06R-3 (3 SETS)	R5170C-06028-3
R5166M-08036	R5166R-08R-3 (3 SETS)	N/A
R5170M-10044 R5170M-10049	R5166R-10R-3 (3 SETS)	N/A
R5170M-12054 R5170M-12058	R5166R-12R-3 (1 SET)	N/A
R5170M-16065 R5170M-16073	R5166R-16T-3 (1 SET)	N/A

NOTES:
1. RESURFACING TOOL PART NUMBERS SHOWN WILL PROVIDE A COMPLETE RESURFACING TOOL LESS EMERY DISCS. WHEN SET R27500GT IS ORDERED, RESURFACING TOOL COMPONENTS ARE PROVIDED SO THAT A COMPLETE TOOL IN ANY SIZE IS AVAILABLE.
2. ALL TOOLING SHOWN ON THE FIGURE MAY BE ORDERED INDIVIDUALLY BY PART NUMBER LISTED.
3. OPTION KITS: R27501GT-11 MAY BE ORDERED IN GROUPS OR KITS AS SPECIFIED. ORDER AS A KIT, IT WILL SUPPLY ONE MANDREL AND ROLLER SET FOR EACH EXPANDER SIZE SHOWN, AND ONE EACH EXPANDER CAGE FOR 04, 06, AND 08 SIZES. THE NUMBER OF ROLLERS PER SET IS DESIGNATED BY LAST DIGIT IN ROLLER PART NUMBER.

Figure 5. Typical Field Installation and Repair Tool Kit (Sheet 4)

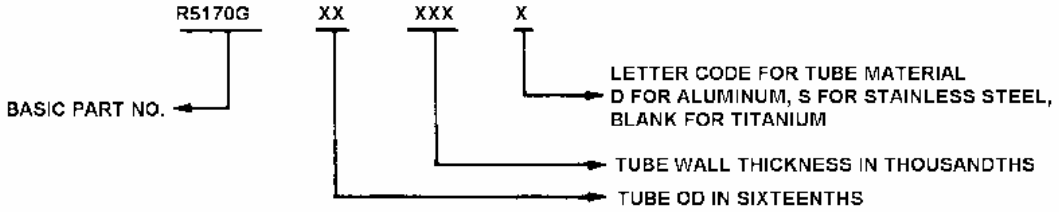


EXPANDER COLOR CODE FOR INTENDED TUBE MATERIAL

COLOR	USED ON TUBE MATERIAL
YELLOW	TITANIUM
GREEN	STAINLESS STEEL
YELLOW/GREEN STRIPE	TITANIUM AND STAINLESS STEEL
BLUE	ALUMINUM

NOTE:

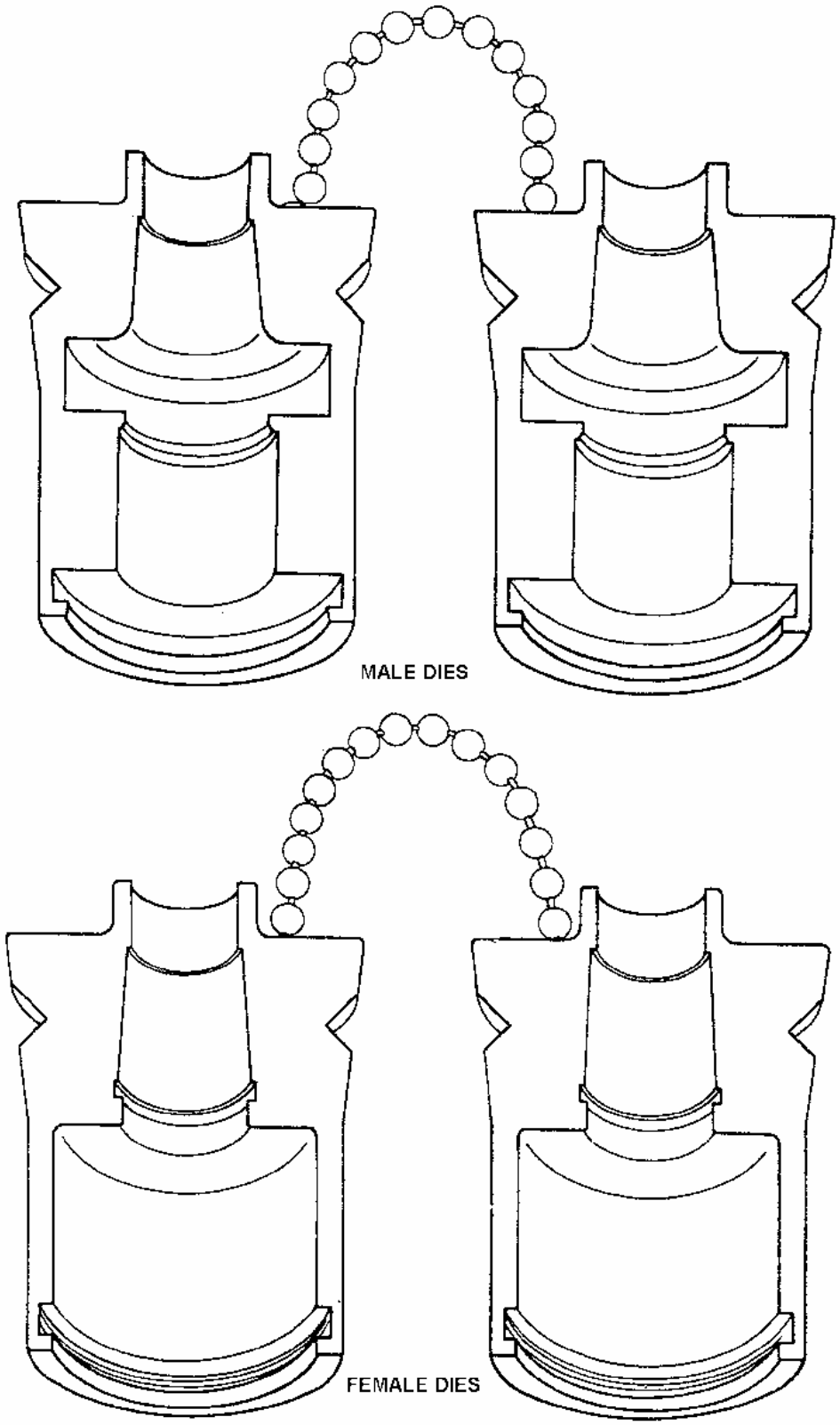
1. EXPANDER PART NO.



EXAMPLE: R5170G - 10044 REPRESENTS A NAVY EXPANDER FOR 5/8 (i.e. 10/16) OD TUBING WITH A .044-INCH WALL THICKNESS OF TITANIUM.

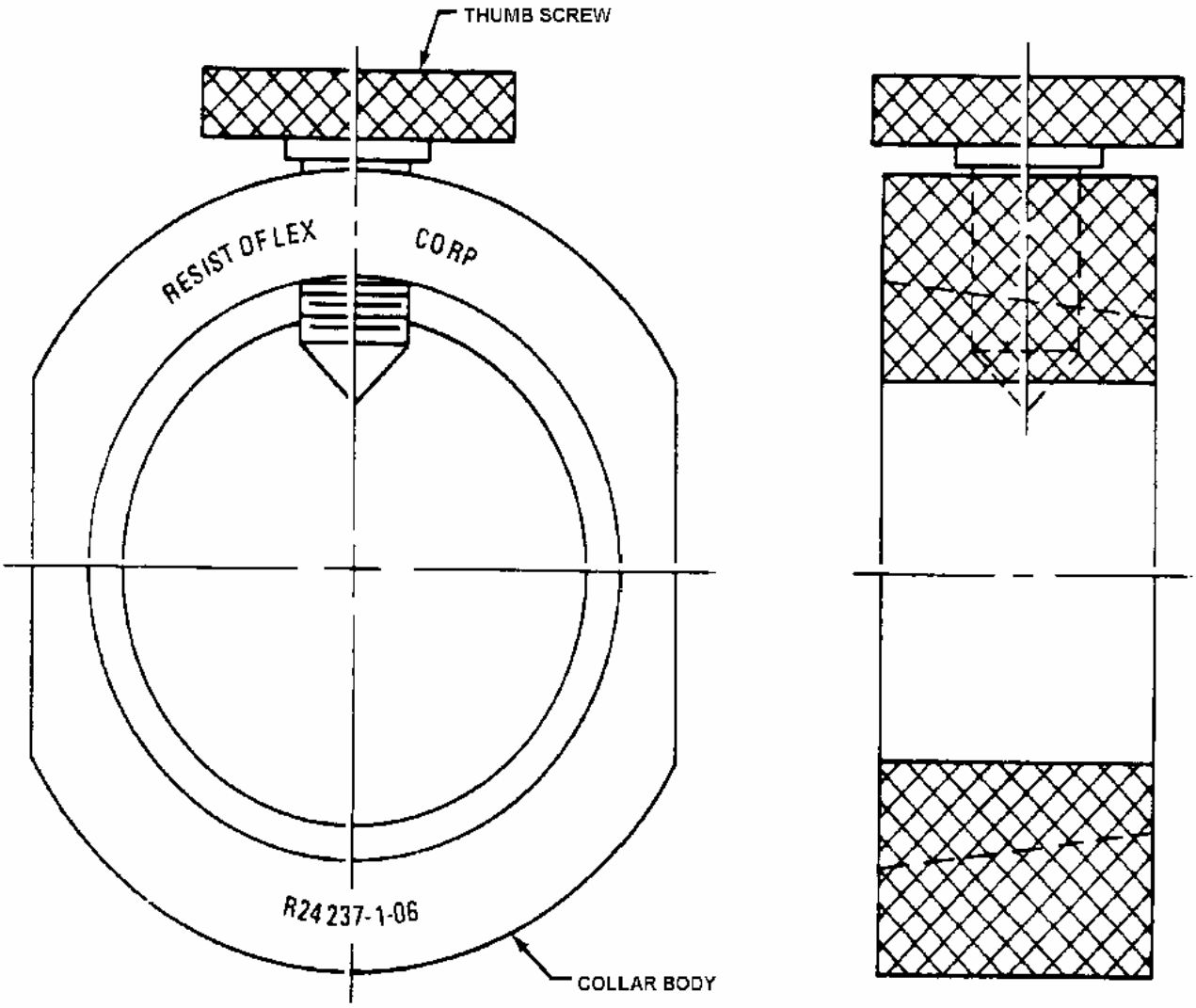
013006

Figure 6. Tube Expander and Identification Band



013007

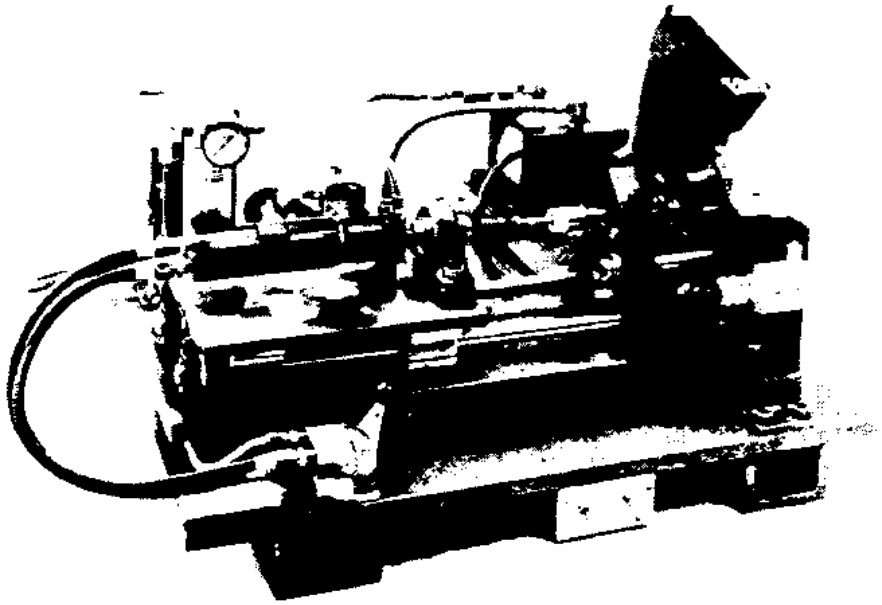
Figure 7. Typical Holding Fixture Dies



COLLAR BODY	USE WITH DIE SIZE
06	04, 06
12	08, 10 & 12
16	16

013008

Figure 8. Typical Holding Fixture Collar



MODEL	SIZE RANGE	ACCOMMODATES TUBE BENDS
R27575	1/4 THROUGH 5/8 INCH	180 DEGREES ON CENTER LINE RADIUS
R27564	1/4 THROUGH 1 1/2 INCHES	90 DEGREES ON CENTER LINE RADIUS

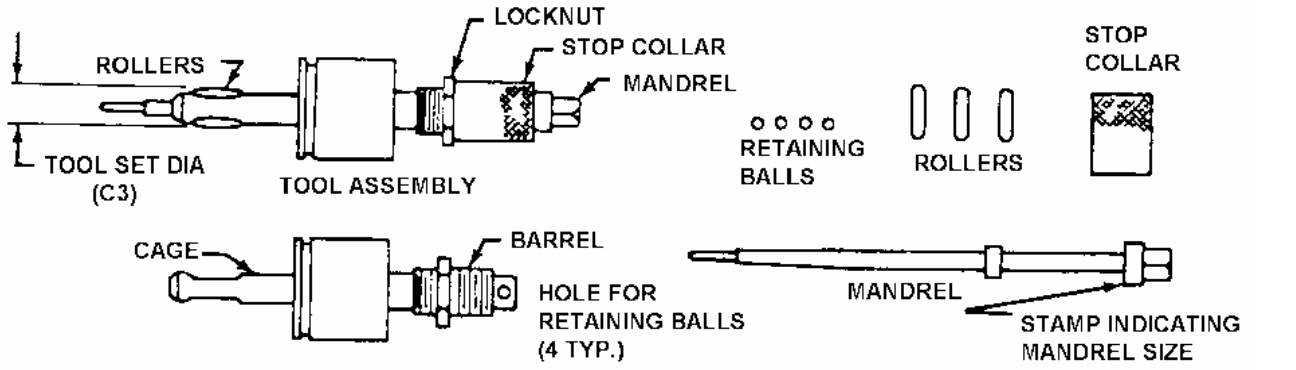
013009

Figure 9. Resistoflex Production Swaging Machine

Table 2. Expander Set Dimensions

Expander Size	Tube Material	Set Diameter (C-3) (Note 1) +.001 (Allowable Tolerance -.000 (Inches)
R5170G-04020 S	304 1/8 Hard	.230
R5170G-06028	3AL-2.5V Ti	.342
R5170G-06028 S	304 1/8 Hard	.339
R5170G-08035 S	304 1/8 Hard	.455
R5170G-08036	3AL-2.5V Ti	.455
R5170G-10044	3AL-2.5V Ti	.567
R5170G-10049 S	304 1/8 Hard	.558
R5170G-12054	3AL-2.5V Ti	.674
R5170G-12058 S	304 1/8 Hard	.671
R5170G-16065 S	304 1/8 Hard	.907
R5170G-16073	3AL-2.35V Ti	.896

Notes: 1. Above expander set diameters (C-3) are for the typical tools shown in Figure 5.



013010

Figure 10. Dynatube Expander Components

c. Pull stop collar from barrel and catch four retaining balls. Retaining balls may fall as soon as stop collar exposes them.

d. Remove retaining balls which have not fallen out and place them in a container.

e. Remove mandrel by pulling it out of barrel and stop collar.

f. Hold tube expander with cage down and guide one roller at a time into cage bore and then out from the tip of cage.

g. Clean and check removed rollers (Figure 11) and mandrel for evidence of deterioration. Mandrels and rollers which show discoloration or heat strain, but otherwise are smooth and free of wear, are all right for continued service.

h. Replace mandrels or rollers that show evidence of deterioration.

18. Assembling Tube Expander. When assembling tube expander (Figure 10), use new components where applicable and proceed as follows:

a. Insert mandrel into stop collar.

b. Insert mandrel and stop collar into barrel and cage. Do not engage stop collar thread.

c. With mandrel tip just behind roller cavity of cage, install rollers. Use a pencil or pin to guide rollers one at a time into cage slots so that larger diameters (on end with radius) of rollers are toward tip of cage.

NOTE

Each roller is tapered to complement the mandrel taper. Cage slots are also tapered and will not readily accept a roller in reverse position.

d. With rollers in place, push mandrel deeper into tube expander to prevent rollers from falling out.

e. Insert retaining balls. Make sure mandrel collar is within barrel.

f. Engage stop collar threads with barrel threads.

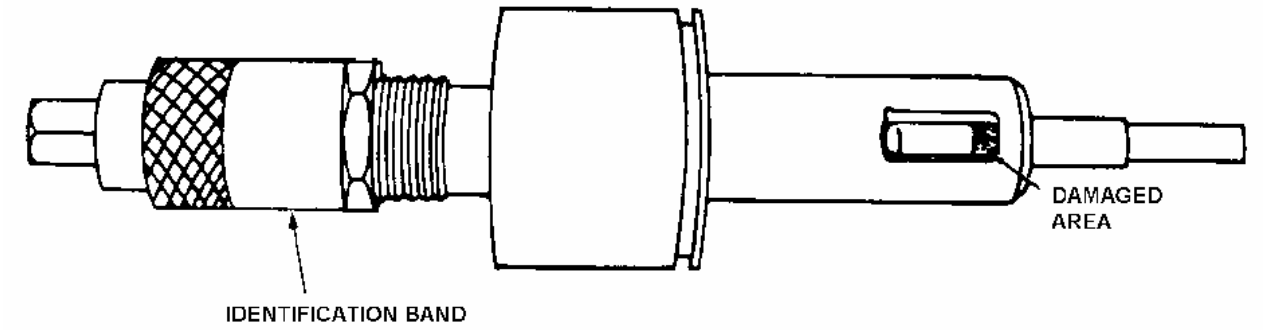
NOTE

The number shown on the expander identification band is the final diameter of the swaged tube; the tube expander is always set to a greater value.

g. Adjust tube expander setting to C-3 value as described in the paragraph above.

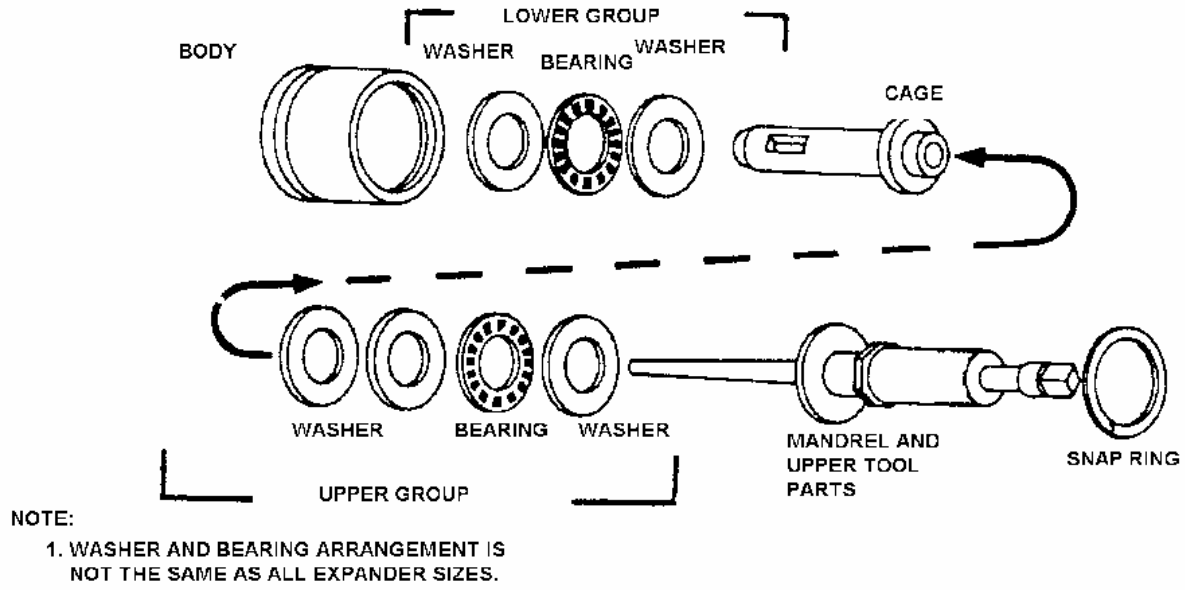
19. Replacing Tube Expander Cage. Replace cage if peen along sides of roller cavity breaks down, allowing rollers to fall out of tube expander. To disassemble cage (Figure 10 and 12), proceed as follows:

a. Use a fine screwdriver, pencil or pin to remove snap ring.



013011

Figure 11. Typical Roller Damage



013012

Figure 12. Typical Expander Internal Components

b. Holding stop collar, lift upper portion of tube expander (stop collar, locknut, barrel, and mandrel) out of body. Retain bearings and thrust washers within body.

c. With the mandrel removed, the rollers will be free to fall into bore and out from front of cage. Rollers which do not fall out shall be guided out manually.

d. Place rollers into a container.

e. Holding tube expander body with cage pointing down, slowly push cage up and out of body.

f. Retain (lower group) washers and bearings on roller side of cage collar in body.

g. Set (upper group) washers and bearings aside without disturbing assembly sequence.

20. Assembling Tube Expander Cage. When assembling tube expander cage (Figures 10 and 12), replace cage as follows:

CAUTION

Location and arrangement of bearings and thrust washers within tube expander body are critical. Washers and bearings are separated into two groups, one remaining within body (lower group) and the other (upper group) set aside.

a. Place cage into body so cage collar rests on uppermost washer within body.

b. Insert upper-group washers and bearings into body keeping their original sequence.

c. Insert mandrel with upper tool parts into cage until tip just touches roller slots.

d. Insert rollers, one at a time, through cage bore. When all rollers are within slots, insert mandrel further to prevent rollers from falling out.

e. Turn tube expander to vertical position with cage pointing down.

f. Holding tool vertically, guide barrel and internal parts down into body.

g. Maintaining a downward pressure on the mandrel, position the snap ring into its groove. The recommended method is to locate the lower end of the ring and then, using a pin or fine screwdriver, force this end down within the body and into the groove. Then progress around the body, guiding the remainder of the ring into the groove to complete the assembly.

21. Measuring Tube Expander Insertion Depth. Insertion depth of tube expander into tubing is determined by dimension E (Figure 13). To measure expander insertion depth, proceed as follows:

CAUTION

Check the insertion depth and C-3 dimension. A discrepancy of the insertion depth indicates improper positioning of the thrust washers and bearings. If the C-3 measures greater than specified, the insertion depth may be less than nominal. If the C-3 measures less than specified, the insertion depth may be more than nominal.

a. Install fixture on tube expander as shown in Table 3.

b. With mandrel fully depressed, mean measure E dimension, using an optical comparitor, vernier, or micrometer height gage.

22. REPAIR METHODS USING DYNATUBE FITTINGS.

Materials Required

Specification or Part Number	Nomenclature
MIL-T-81772	Thinner

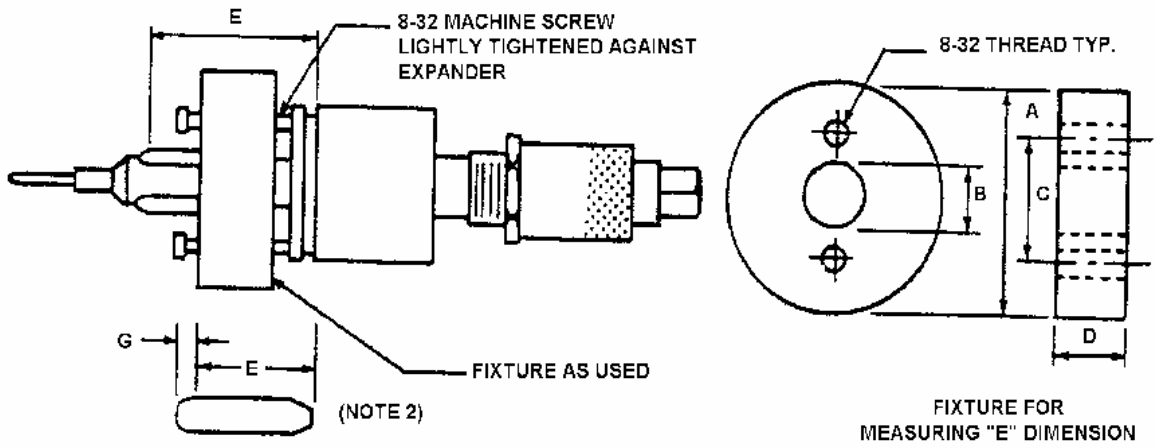
23. The repair methods described in this manual are as follows:

a. Replacing Dynatube fittings on existing tubing by using longer length Dynatube fittings (Figures 13, 14 and Table 4).

b. Repairing male Dynatube fitting sealing surface with special tooling as shown in Figures 15 and 16.

c. Repairing damaged straight tubing, using Dynatube splice assembly (Table 5).

Table 3. Tube Expander Insertion Depth Measurement



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Expander Size	G	±.010 R5170 Series	E ±.010 R5166 Series	A Min.	B+.005 -0 (Note 1)	C ±.010	D Max.
-04	.050	1.330	1.330	1.000	.193	.650	.500
-05				1.250	.245	.750	
-06				1.500	.310	.806	
-08	.095	1.490	1.490	1.500	.411	1.000	.625
-10		1.757	1.500	1.750	.520	1.100	.750
-12		1.794	1.500	1.750	.620	1.255	
-14		2.010	NA	2.000	.740	1.520	1.000
-16		2.010	1.915	2.000	.860	1.520	
-20		2.262	1.975	2.500	1.100	1.900	
-24		2.519	2.093	2.750	1.324	2.200	1.250

Notes:
1. Bore diameter shown will accommodate most expander sizes. Certain expanders designed for heavy wall tubing should have fixtures with reduced bore diameters to provide close fit to the applicable cage diameter.
2. Dimension E is figured from point on roller where front radius becomes tangent to straight portion of roller to far face of groove in expander body. Since this is a difficult point to locate, G dimension is provided. This dimension permits measuring to end of roller and subtracting G to determine value of E.
3. All dimensions are in inches.

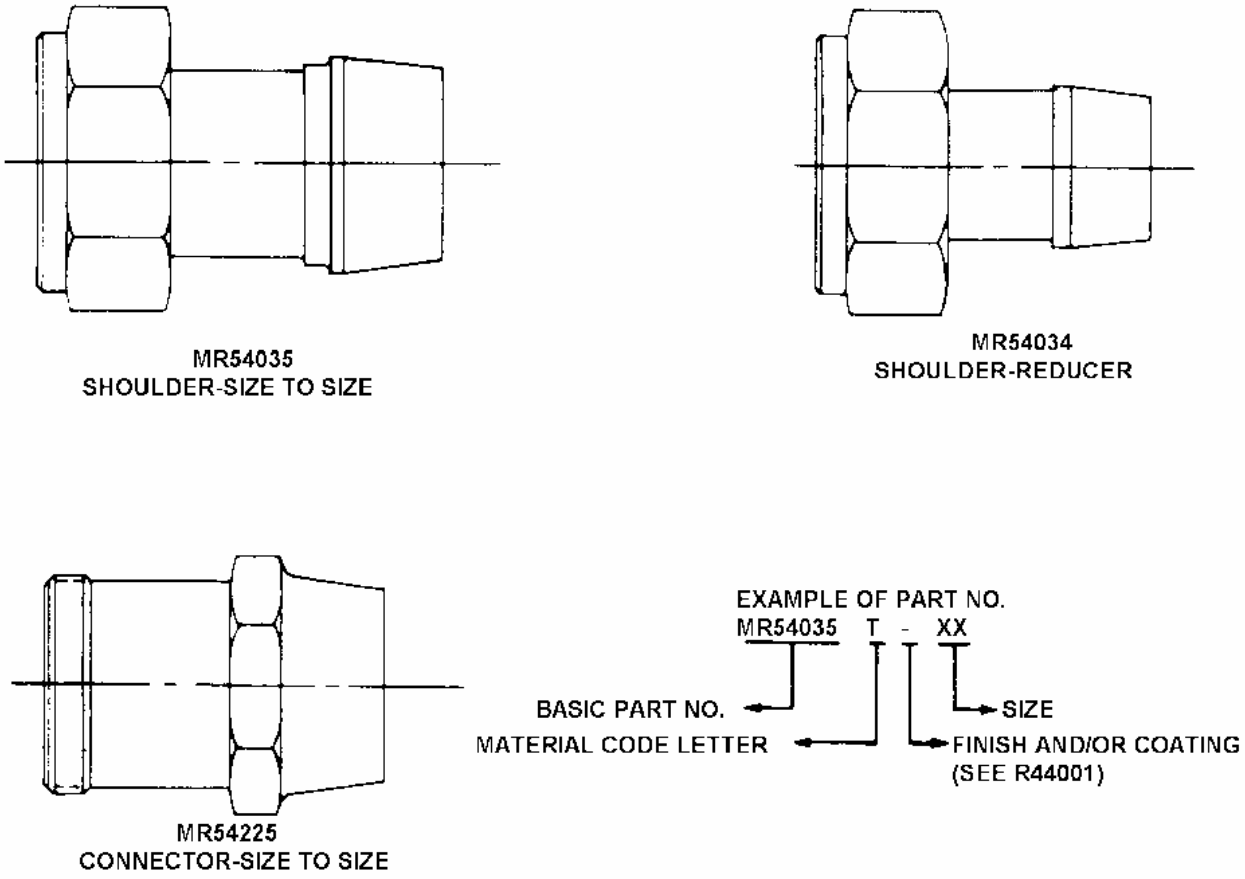

Figure 13. Dynatube Repair Fittings

24. REPLACING DAMAGED MECHANICALLY SWAGED DYNATUBE FITTINGS. Longer length Dynatube fittings can be installed in place of damaged fittings on the same tube assembly. There shall be enough straight tubing between the damaged fitting and the nearest bend to allow clearance for the fitting and tools. To repair a damaged mechanically swaged Dynatube fitting, proceed as follows:

a. Use a tube cutter to cut tube adjacent to damaged fitting. Make sure cut is square (Figure 14).

b. Deburr tube end and chamfer Inner Diameter (ID) to 60 degrees. If necessary, .005 inch may be removed from cut tube face for cleanup.

c. Install replacement fitting and swage in accordance with Paragraph 35 or 39.

d. Measure inside diameter of swage area for conformance with finished swage dimension shown on expander identification band (Paragraph 36 or 40).

e. Clean swaging lubricant from assembly with a lint-free cloth.

f. Pressure test tube assembly in accordance with WP009 00 and return to service.

25. REPAIRING DAMAGED WELDED DYNATUBE FITTINGS. To repair a damaged welded Dynatube fitting using a longer Dynatube fitting, proceed as follows:

a. Use tube marking gage R24837-16-40 (50599) to measure replacement fitting as shown in Figure 17.

b. Without moving slide setting made in step a, remove replacement fitting and measure damaged fitting as shown in Figure 17.

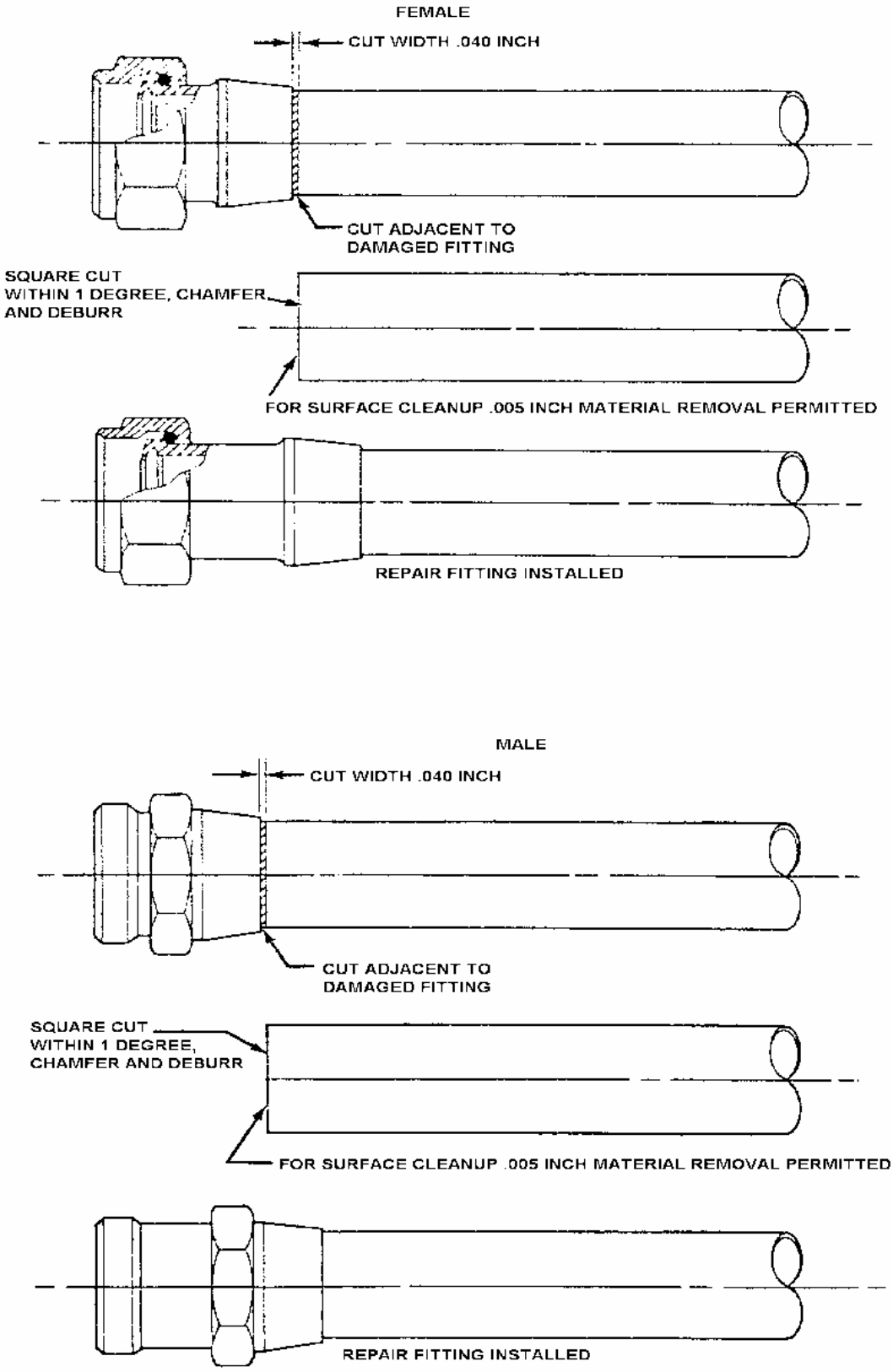

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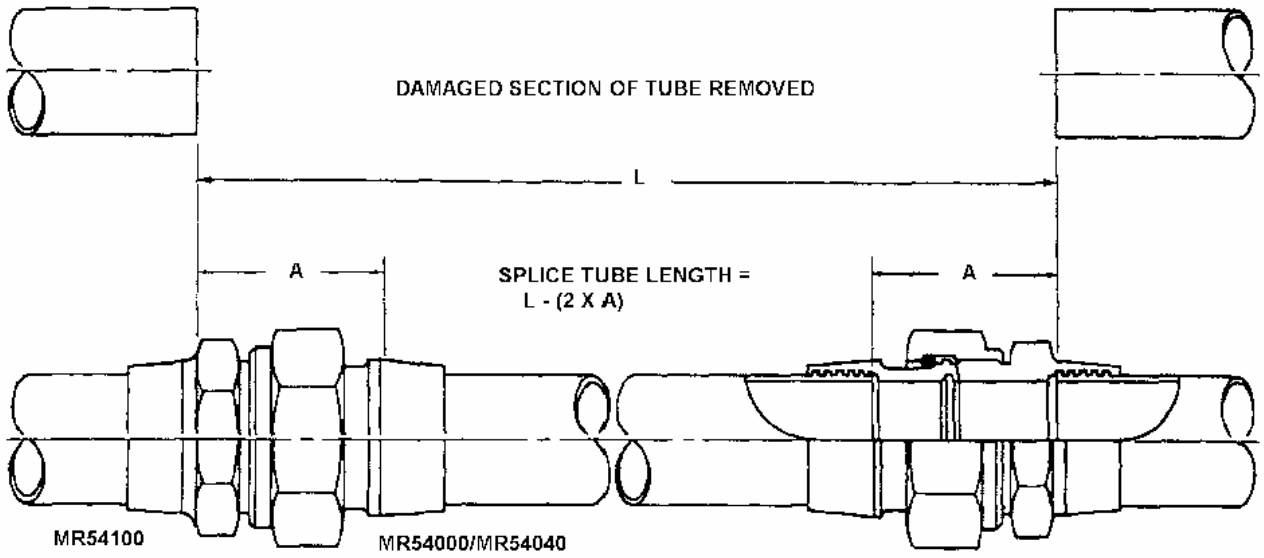
Figure 14. Male and Female Repair Fitting Installation

Table 4. Standard and Repair Dynatube Swage Fittings

Standard Female Titanium Dynatube	**Repair Female Titanium Dynatube**
Part No.	**Part No.**
MR54040T-03 -04 -05 -06 -08 -10 -12 MR54042T-16 MR54040T-2120 -2524	MR54035T-03 -04 -05 -06 -08 -10 -12 -16 -2120 -2524
Standard Female Reducer Titanium Dynatube	**Repair Female Reducer Titanium Dynatube**
Part No.	**Part No.**
MR54027T-0403 -0504 -0604 -0806 -1008 -1210 -1612 MR54029T-2116 MR54027T-2520	MR54034T-0403 -0504 -0604 -0806 -1008 -1210 -1612 -2120 -2520
Standard Male Titanium Dynatube	**Repair Male Titanium Dynatube**
Part No.	**Part No.**
MR54100T-03 -04 -05 -06 -08 -10 -12 MR54200T-16 MR54040T-2120 -2524	MR54225-03 -04 -05 -06 -08 -10 -12 -16 -2120 -2524

Table 5. Splice Assembly Repair



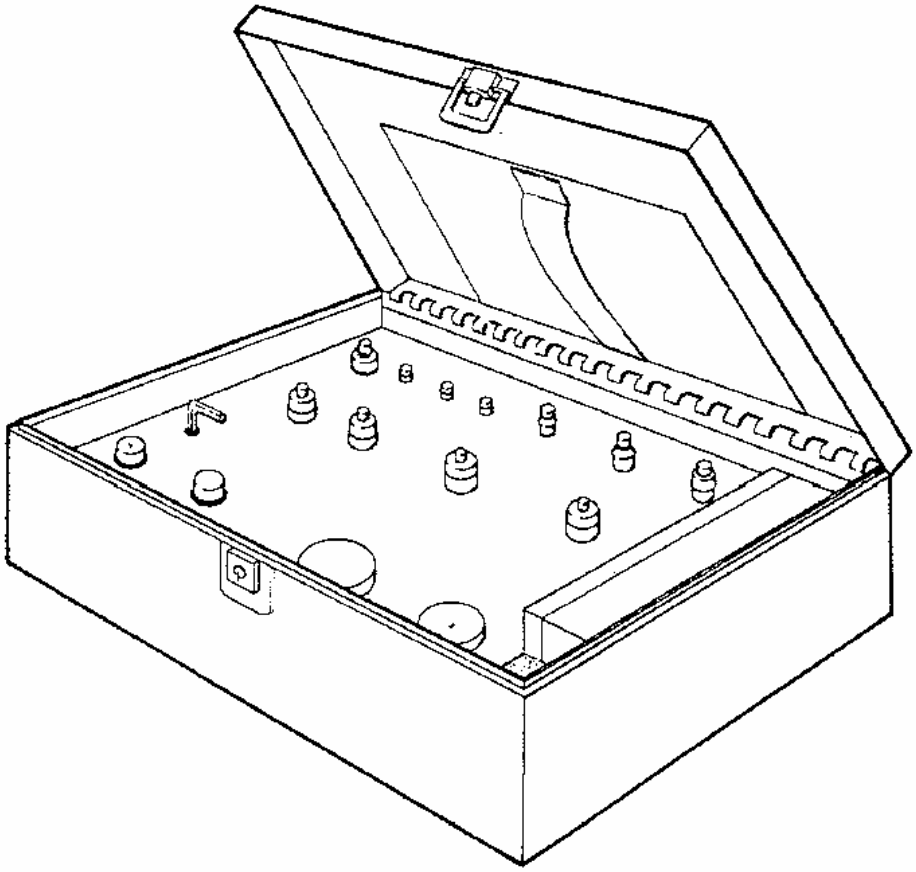
Tube Diameter	*Factor for Splice Tube Length Calculation (2XA)
3/16	1.724
1/4	1.814
3/8	1.988
1/2	2.106
5/8	2.392
3/4	2.560
1	3.032

Sample Calculation:
6.500" of tube cut out of 1/2 diameter line. MR 54000 and MR54100 fittings are to be used. Complete splice length as follows:

Splice tube length =
6.500 - 2.106 = 4.394

*Factor is adjusted to compensate for anticipated tube growth per Table 2.

Notes: 1. All dimensions are in inches.



NOTE

THE DYNATUBE MALE FITTING RESURFACING TOOL AND LUBRICATION REPAIR OR REPLACEMENT MATERIALS KIT PROVIDES ALL NECESSARY TOOL COMPONENTS TO REPAIR ANY MALE DYNATUBE FITTINGS IN SIZES 3/16 TO 1 1/2 INCHES.

013015

Figure 15. Resurfacing Tool Kit, R24837-53

c. Mark tube at index line on jaw plate (Figure 16).

NOTE

Use tube cutter R24837-16-32 in tool kit (Figure 5) or tube cutters R29549-1 for 3/16- to 1/2-inch tube fittings and R29549-2 for 3/16- to 1-1/4 inch tube fittings. Tube cutters R29549-1 and R29549-2 can be ordered separately.

d. Cut tube adjacent to damaged fitting using a tube cutter. Position cutter wheel on side of line closest to damaged fitting (Figure 14). Rotate cutter wheel until fitting separates from tube.

e. Deburr tube end and chamfer ID to 60 degrees. If necessary, .005 inch may be removed from cut tube face for cleanup.

f. Install replacement fitting and swage in accordance with Paragraph 35 or 39.

g. Measure inside diameter of swage area for conformance with finished swage dimension shown on tube expander identification band (Paragraph 36 or 40).

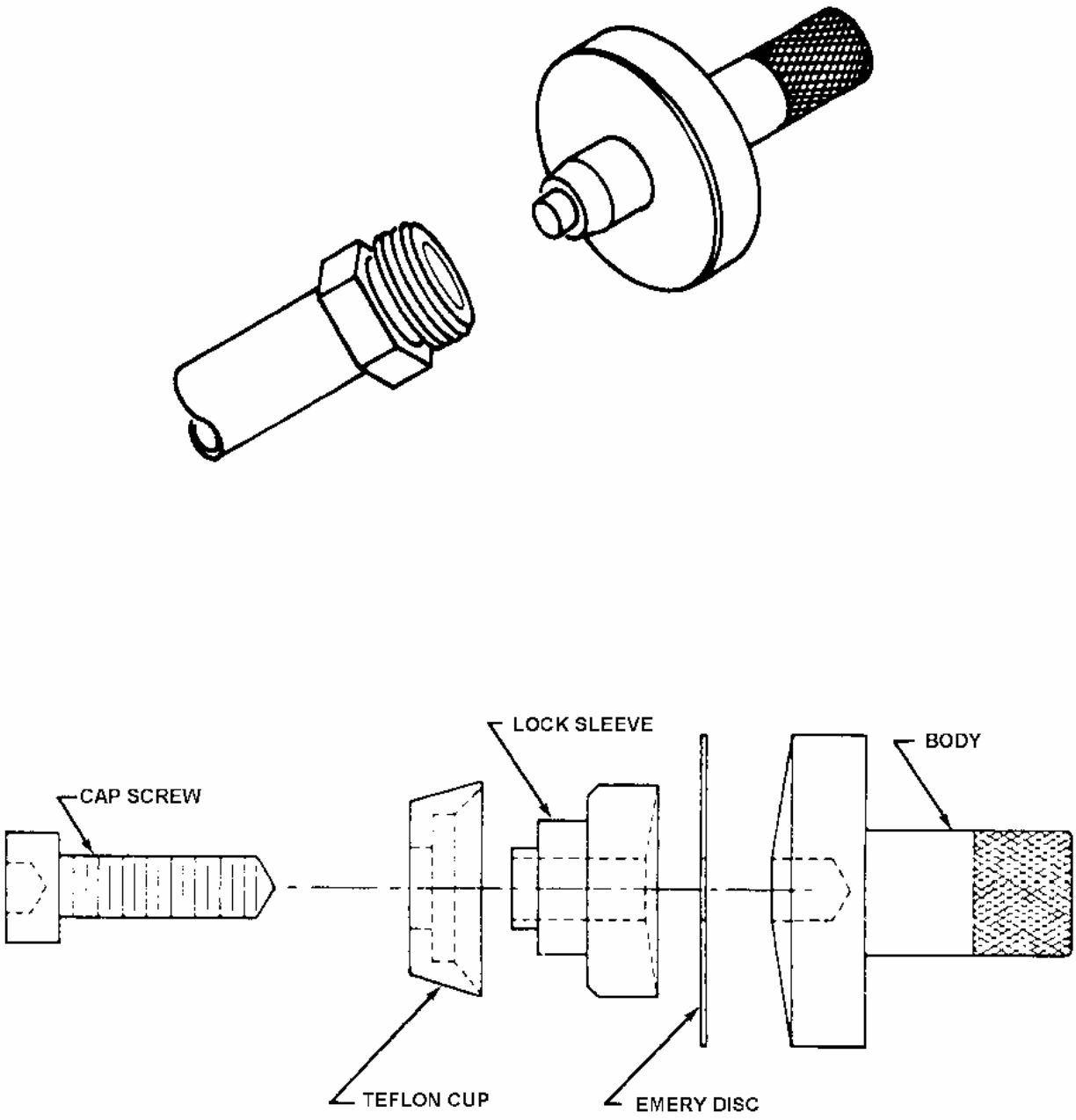


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Figure 16. Resurfacing Tool Components

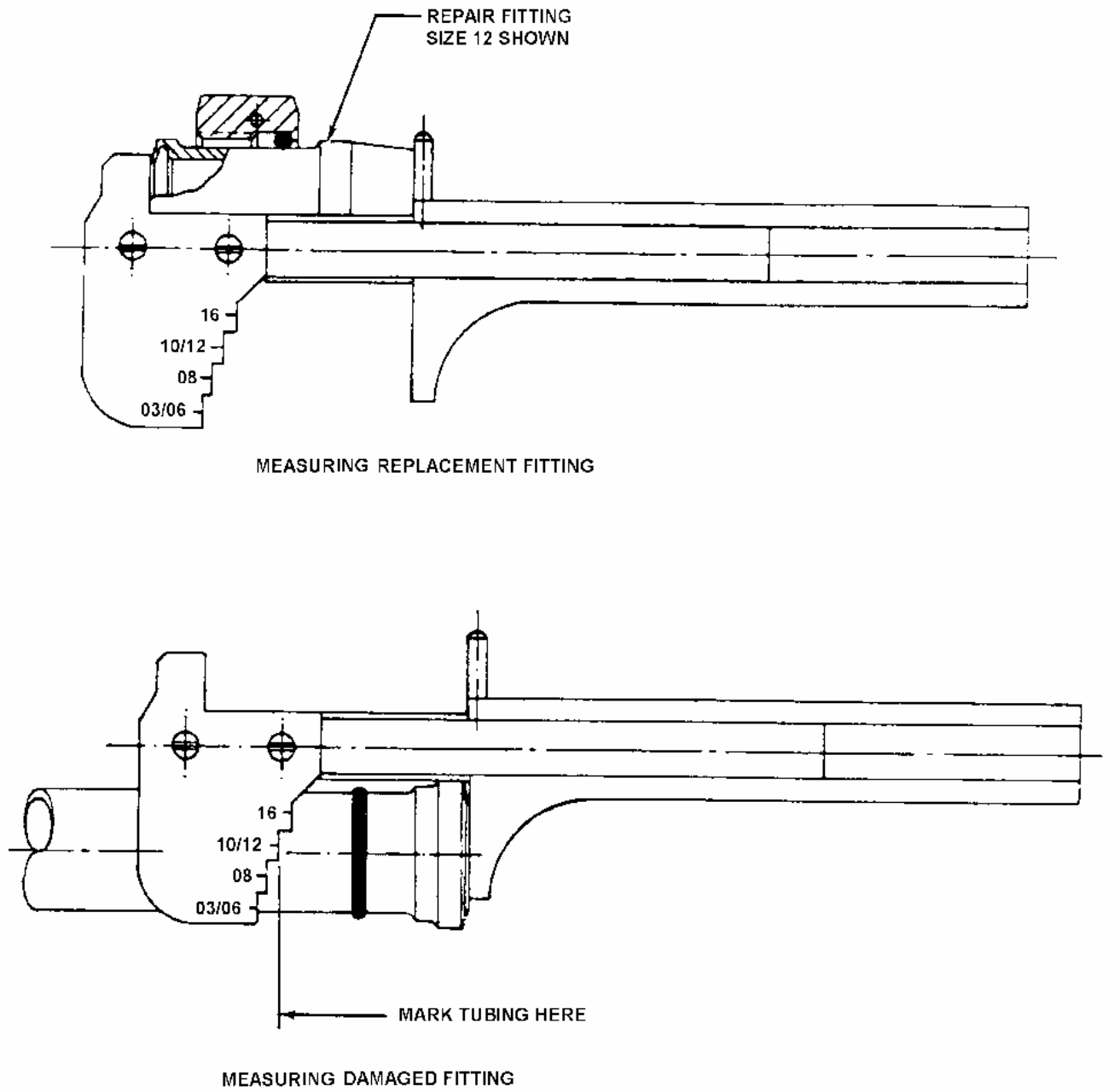

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Figure 17. Measuring Fitting with Tube Marking Gage R24837-16-40 (50599)

h. Clean swaging lubricant from assembly with a lint-free cloth.

i. Pressure test tube assembly in accordance with WP009 00 and return to service.

26. REPAIRING MALE DYNATUBE SEALING SURFACE. Dynatube male fittings with minor surface damage, such as scratches, can be repaired. Do not attempt to repair a damaged female Dynatube fitting. To repair a damaged male Dynatube fitting sealing surface, proceed as follows:

a. Determine size of damaged fitting and select resurfacing tool and proper size emery disc kit (Figure 16).

b. Remove cap screw from resurfacing tool (Figure 16). Without disturbing order of lock sleeve and teflon cup, insert coarse grit emery disc against convex surface of tool body with grit facing out. Reassemble tool and finger tighten cap screw.

c. Insert resurfacing tool into fitting until emery disc contacts sealing surface.

NOTE

Some force may be required to push teflon cup into fitting bore, but this tight fit ensures removal of dust when tool is withdrawn.

d. Rotate resurfacing tool back and forth against fitting until smooth surface is obtained. Rotate fitting occasionally to keep abrasive action uniform.

e. Remove resurfacing tool and repeat steps a through d, using progressively finer emery discs until sealing surface is free of scratches.

Thinner, MIL-T-81772 **16**

f. Clean sealing surface with thinner MIL-T-81772 and cotton swabs provided in lubrication repair kit (Figure 5). Allow 2 minutes to dry solvent and cotton swabs provided in lubrication repair kit (Figure 5).

g. Shake lubricant vial until contents are thoroughly mixed. Use a clean cotton swab to apply lubricant to sealing surface in one sweeping motion while rotating cotton swab. Air dry for 10 minutes.

27. REPAIRING DAMAGED STRAIGHT TUBING USING DYNATUBE SPLICE ASSEMBLY. To repair a damaged straight section of tubing, proceed as follows:

a. Cut out damaged section of tubing.

b. Chamfer and deburr cut ends of tubing to be retained.

c. Measure length “L” between cut ends of tubing (Table 5).

d. Install male Dynatube fittings on cut ends in accordance with Paragraph 35 or 39.

e. Calculate length of splice tube. Length of splice tube = L-2A. Values of 2A are shown in Table 5 and “L” is obtained from step c.

f. Cut length of splice tubing to size determined in step e. Tubing shall be the same or equivalent stock as damaged tubing (WP008 00).

g. Pressure test tube assembly in accordance with WP009 00 and return to service.

28. PRESWAGING INSTRUCTIONS.

29. To prepare tubing and fittings for swaging, check the following:

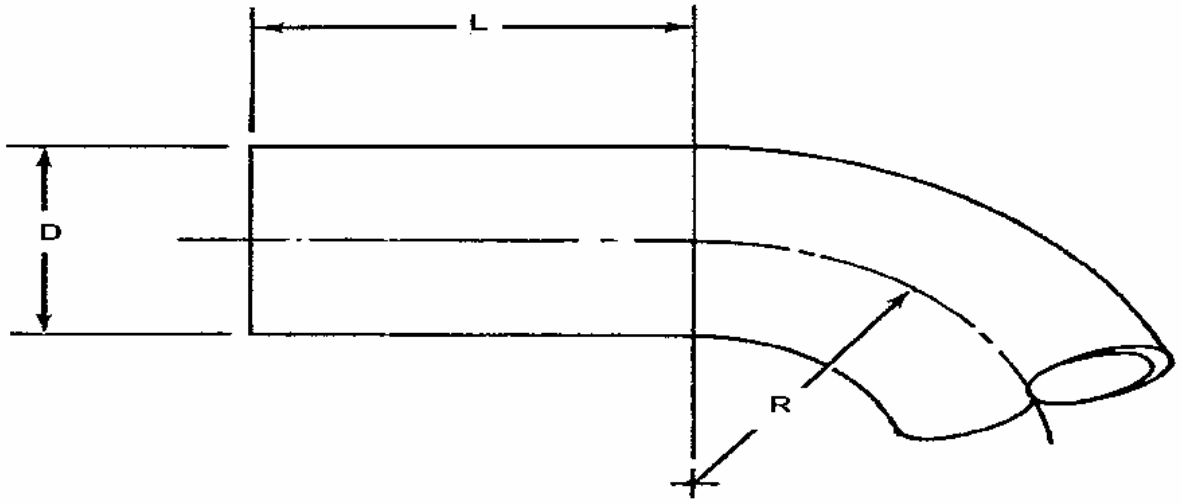
a. Location of tubing bends.

b. Longitudinal growth in tubing due to swaging.

c. Tube end preparation.

30. LOCATION OF TUBING BENDS. Dynatube tooling requires a minimum straight length to be maintained between cut tube end and nearest bend tangent point to provide for mandrel clearance. A minimum straight length of tube is also required to assure presence of undisturbed cylindrical tubing at fitting. Table 6 lists the minimum allowable length of straight tubing to a 25 degree or greater bend tangent point.

Table 6. Minimum Straight Tubing Requirement



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D OD Tube Size	Minimum Allowable Length L (Inches)
1/4	1.000
3/8	1.000
1/2	1.000
5/8	1.000
3/4	1.000
1	1.150

Notes: 1. All dimensions are in inches.

31. LONGITUDINAL GROWTH IN TUBING DUE TO SWAGING. Action of Dynatube expanding tools during mechanical swaging expands tube into groove of fitting receptacle. At the same time, the tube is rolled to a thinner cross section, displacing material outward from fitting and increasing effective length of tubing. Amount of longitudinal tube growth is a function of tube size, fitting size, and swage parameters. Table 7 lists growth per fitting end. Numbers shown are for nominal dimension tubing. Wall thickness greater than nominal will result in more growth.

NOTE

Table 5 takes longitudinal growth into account when calculating length of required tube splice.

32. TUBE END PREPARATION. To prepare tube end for swaging, proceed as follows:

a. Determine tube diameter, wall thickness, and material.

Table 7. Longitudinal Growth in Tubing Due to Swaging

Size (Inches) Tube OD and Wall Thickness	Longitudinal Growth per Fitting Attachment End (Inches) (Notes 1, 2 and 3)
3/16 x .020	
1/4 x .020	.018
3/8 x .028	.017
1/2 x .035	.025
1/2 x .036	.029
5/8 x .044	.033
5/8 x .049	.028
3/4 x .054	.033
3/4 x .058	.034
1 x .065	.037
1 x .073	.046

Notes:
1. Longitudinal growth of typical tubing.
2. Longitudinal growth is already taken into account in Table 5.
3. Example to illustrate method of compensating for anticipated tube growth: Assume a straight length of 5/8 x .044 size titanium tubing to have Dynatube fittings swaged to each end. Cut tube length is determined to be 4.625 inches. Based on table above, nominal growth at each end is .033 inch; therefore, correct cut tube length would be:

Cut Tube Length = 4.625 - 2 (.033)

= 4.559 inches

b. Select hand tools (Figure 5) relative to tube diameter, wall thickness, and material.

c. Cut tube.

NOTE

Tube Outer Diameter (OD) shall have a square edge, but a 60-degree chamfer is recommended for tube ID as shown in Table 8.

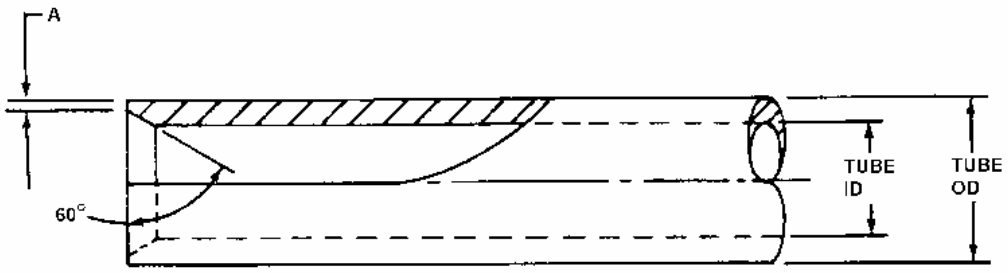
d. Remove any distortion produced by a rolling cutter.

e. Clean tube end with a lint-free cloth.

33. SWAGING.

34. Due to the differences in hand tools, instructions for internal mechanical swaging of Dynatube fittings for -03 size differ from instructions for all other sizes. Figure 18 shows a size -03 tube expander assembly with fewer components as compared to the tube expander assembly for all other sizes shown in Figure 10.

Table 8. Tube End Preparation Data



013t08a

Tube Wall Thickness	A
.016 through .022	.005
.023 through .040	.015
.041 through .050	.020
.051 through .060	.040
.061 and thicker	.050

Notes: 1. All dimensions are in inches.

35. SWAGING INSTRUCTIONS FOR SIZE -03 DYNATUBE FITTINGS. To swage size -03 Dynatube fittings, proceed as follows:

a. Remove fitting from package. Make sure all packing material is removed from fitting.

b. Slip tube into fitting.

c. Clamp tube with tube clamp (Figure 5) and hand tighten clamp.

d. Place assembly in a bench vise with vise jaws gripping tube clamp and insert punch (Figure 5) into fitting bore.

e. Use a small hammer to tap punch several times to produce a bellmouthing of tube into first serration of fitting.

f. Remove punch when tube has become staked so it will resist pullout from fitting.

g. Check that tube is against tube stop in fitting and has not backed out. The fitting shall be finger-tight against rotation at this time.

h. Place tube and fitting into die half.

i. Position thrust case as shown in Figure 18 and place in die half. Cover with mating die half, slip on collar, and tighten thumbscrew handtight.

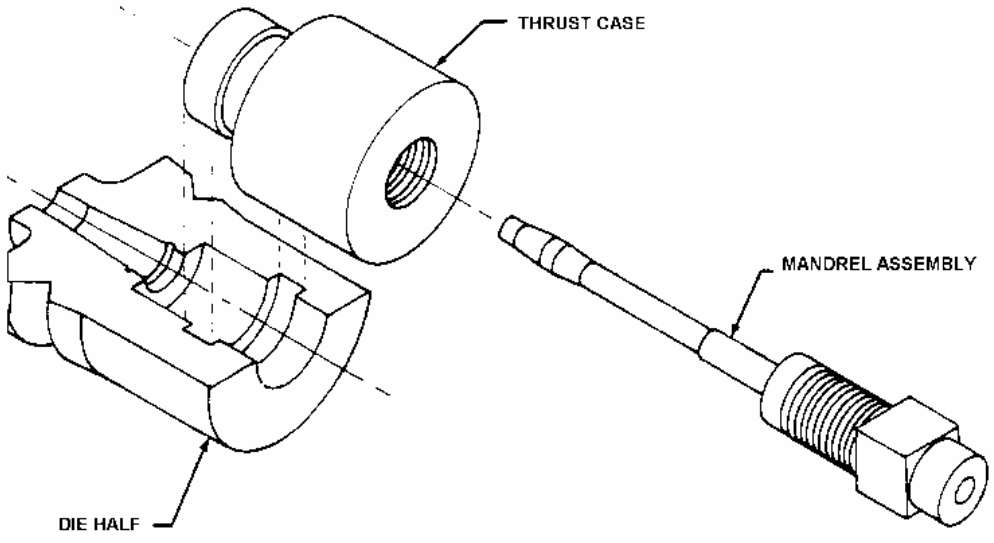
j. Clamp tube expander assembly in vise with jaws gripping flats on collar.

k. Apply lubricant to bulbous portion of mandrel (Figure 5).

l. Insert mandrel assembly into thrust case.

m. Use an open-end wrench to turn in mandrel drive until stop is contacted.

n. Back out mandrel by turning mandrel drive counterclockwise.



013018

Figure 18. Expander Assembly, Size -03

o. Remove assembly from vise.

p. Remove tube assembly by loosening thumbscrew, removing collar and separating die halves.

q. Check expanded tube inside diameter in accordance with the paragraph below.

36. CHECKING SIZE -03 SWAGED DYNATUBE FITTING JOINT. The inside diameter gage (Figure 5) used the die set and thrust case of the tube expander to position tube fitting assembly during checking. The inside diameter gage includes two pins of different diameters and lengths (Figure 19). The longer, thinner pin has a radius on the tip and is used to check the expansion diameter. The pin diameter is .156 inch. The shorter pin is .164 inch in diameter and has a squared-off tip. It is used to check for possible tube pushout due to improper swaging.

37. CHECKING SIZE -03 SWAGED DYNATUBE TUBING JOINTS. To check size -03 swaged Dynatube tubing joints, proceed as follows:

a. Place swaged fitting in die set; assemble thrust case and collar as shown in Figure 19.

b. Insert 156-inch diameter pin through thrust case bore into fitting.

NOTE

If the aluminum hex handle of inside diameter gage butts against face of thrust case, the expansion diameter is proper and of sufficient length.

38. CHECKING SIZE -03 SWAGED DYNATUBE FITTINGS FOR TUBE PUSH-OUT. To check size -03 swaged Dynatube fittings for tube pushout, proceed as follows:

a. Place swaged fitting in die set; assemble thrust case and collar as shown in Figure 19.

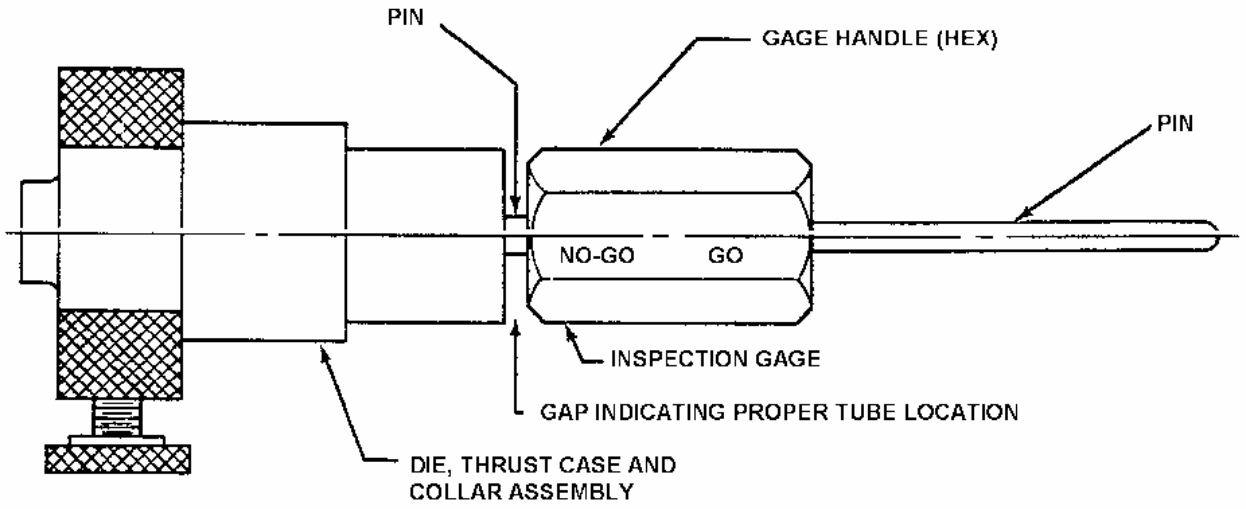
b. Insert .164-inch diameter pin into thrust case bore.

NOTE

Tip of pin should contact tube end within fitting. If tube is in its proper location, inside diameter gage cannot fully insert and aluminum hex handle of gage will stand away from thrust case face.

39. SWAGING INSTRUCTIONS FOR ALL SIZES EXCEPT SIZE -03. To swage Dynatube fittings of all sizes except -03, proceed as follows:

a. Remove fitting from package. Make sure all packaging material is removed from fitting.



013019

Figure 19. Checking Swage Dynatube Fitting, Size -03

NOTE

Reducer fittings use a noncaptive nut which will not fit between die halves. Slide nut back down the tube to be out of the way of tooling.

b. Slip fitting onto tube until tube touches positive stop on inside diameter of fitting.

c. Check condition of tube expander assembly. Repair or replace mandrel or rollers that show signs of pitting or chipping (Paragraph 17).

d. Check C-3 value of tube expander setting (Paragraph 15). Adjust tube expander setting if necessary (Paragraph 16).

e. Lubricate tube expander, rollers, and mandrel with lubricant (Figure 5).

f. Position tube expander mandrel in full retracted position (tip of mandrel within expander).

g. Insert tube expander into fitting.

h. Position tube expander-tube fitting assembly in one die set half by placing tube expander lip into groove of die and fitting into die set nest Figure 20.

i. Turn mandrel clockwise until fingertight.

j. Assemble second half of die set over first half.

k. Holding assembled die halves together, slip holding collar over assembly as shown in Figure 20.

CAUTION

Avoid positioning thumbscrew over die parting line. Position thumbscrew 15 to 90 degrees away from die parting line.

l. Tighten thumbscrew on collar fingertight into V-groove on die set to lock all components in place.

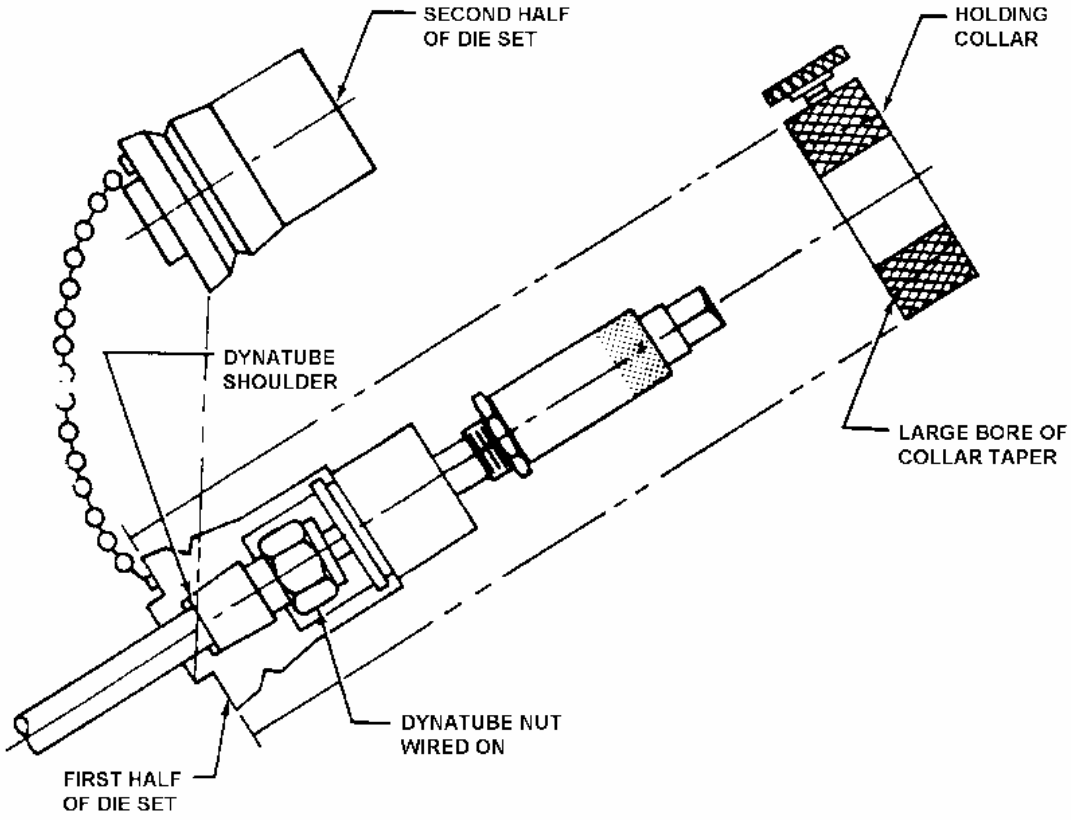
m. Grasp assembly by hand, or for larger sizes, hold assembly in vise, using parallel collar flats as gripping surface.

n. Select an open-end or socked-drive wrench to mate with the square on mandrel drive head.

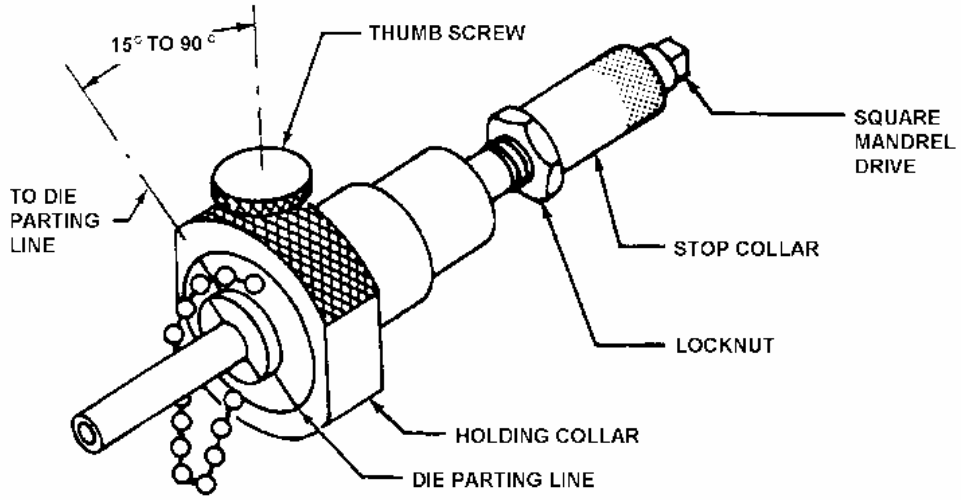
o. Turn mandrel clockwise until drive head touches stop collar, causing stop collar to turn. Continue turning for ten additional turns.

p. Turn mandrel counterclockwise until it backs out freely.

q. Loosen thumbscrew, remove collar, and disassemble die halves.



TUBING AND FITTING POSITIONED IN DIE SET



013020

Figure 20. Dynatube Swaging Process

r. Remove tube expander and tube fitting assembly.

40. CHECKING ALL SIZES EXCEPT -03 SWAGED DYNATUBE FITTING JOINT. After a Dynatube fitting has been swaged to a tube, check finished swaged diameter, using inside diameter gages provided in tool kit (Figure 5). Gage is placed inside socket area and must be rocked to and fro to obtain the smallest reading (Figure 21).

NOTE

Finished swage diameter is expanded Inner Diameter (ID) of tubing throughout socket area of fitting. Acceptable dimension is shown on tube expander identification band (Table 3) and also shown in Table 9.

41. SWAGE ID NOT CORRESPONDING TO ± .0002 TOLERANCE. If measured swage ID does not correspond to ± .002 tolerance of the value shown on expander identification band or as listed in Table 9, check as follows:

a. Check accuracy of inside diameter gage with a calibrated ring gage or micrometer. Make sure check is made at a diameter as close as practical to swage diameter in question.

b. Verify by measurement that tube wall thickness is within ± 0 percent of nominal value shown on tube expander identification band.

c. Clean and check expander in accordance with Paragraphs 13 and 17. An excessively chipped roller will erode mandrel, producing an underswaged assembly.

NOTE

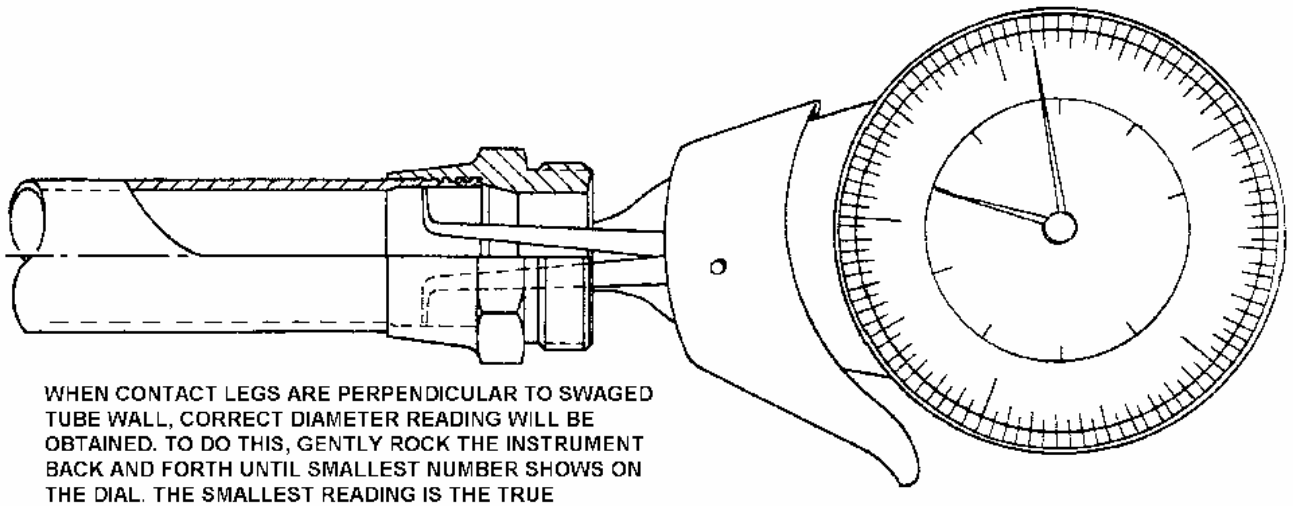
If the checks in the above paragraph cannot determine cause of swaged fitting variance, measure set dimension of tube expander as described in Paragraph 15.

42. INSTALLING DYNATUBE TUBE ASSEMBLY. When installing a Dynatube tube assembly between two fixed points, alignment shall permit connector nut engagement without damaging threads or placing excessive bending stress into tube. Limit of acceptable misalignment depends on length and rigidity of tube assembly. Misalignment shall be limited as follows:

a. Angular misalignment 2 degrees.

b. Lateral misalignment .062 inch.

c. Longitudinal gap .062 inch.



013021

Figure 21. Gaging Finished Swage with Inside Diameter Gage

Table 9. Finished Swage Diameter

Expander Size	Tube Material	Finished Swage ID (Inches ± .002) (Note 1)
R5170G-04020 S	304 1/8 Hard	.226
R5170G-06028	3AL-2.5V Ti	.337
R5170G-06028 S	304 1/8 Hard	.337
R5170G-08035 S	304 1/8 Hard	.450
R5170G-08036	3AL-2.5V Ti	.450
R5170G-10044	3AL-2.5V Ti	.559
R5170G-10049 S	304 1/8 Hard	.553
R5170G-12054	3AL-2.5V Ti	.667
R5170G-12058 S	304 1/8 Hard	.667
R5170G-16065 S	304 1/8 Hard	.900
R5170G-16073	3AL-2.5V Ti	.885
Notes: 1. Above finished swage Inside Diameters (ID) are for typical tools shown in Figure 5.		

43. TUBE ASSEMBLY ALIGNMENT. Sometimes tube runs are difficult to install due to misalignment between separable fittings and port adapter or other fixed termination point. Misalignment is usually caused by incorrectly formed tubing, changes in location of system components, or springback in multibend tubes. Misalignment and springback are evident in systems using titanium tubing; however, most misalignment can be reduced or eliminated by observing the following installation practices:

a. Loosen support clamps at structure to allow float within bracket slot allowance.

b. Install tube assembly by tightening end fitting nuts until seal surfaces are touching.

c. Rotate assembly back and forth until best fit between termination points and support bracket is obtained.

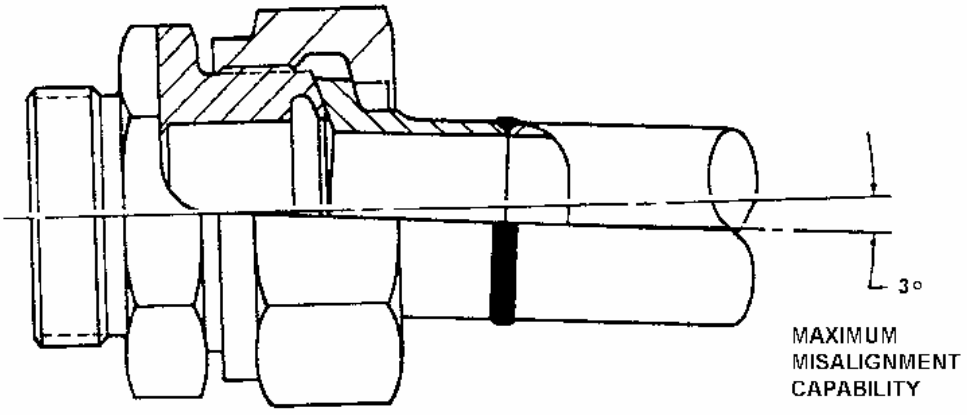
d. Torque support clamps and end fittings to their respective values, using double wrenching where possible.

44. SELF-ALIGNING FITTINGS. Sometimes, even when good installation practices are followed as described in the above paragraph, misalignment still exists, due to aircraft access tube assembly geometry. In such cases, a self-aligning fitting may provide relief (Figure 22). Self aligning fittings allow a maximum 3 degree angular misalignment at each separable end connection without causing side loads on tubing. Self-aligning fittings shall be attached by conventional welding, brazing, or internal swaging. Self-aligning fittings are an alter-native to solve tube assembly repair and installation problems. Because of major differences between self-aligning fittings and other fittings, careful planning of installations is necessary to make sure tube assembly fit and clearance within aircraft structures is adequate (Figure 23 and Table 10).

NOTE

When torquing the coupling to a connector fitting (i.e. MR54100), use the hex flats to restrain the connector from rotating or transmitting torque to the tube assembly.

45. TORQUE VALUES FOR DYNATUBE COUPLING NUTS. Though Dynatube fittings are not torque-sensitive, torque values have been developed (Table 11) to ensure structural reliability of fitting joints.

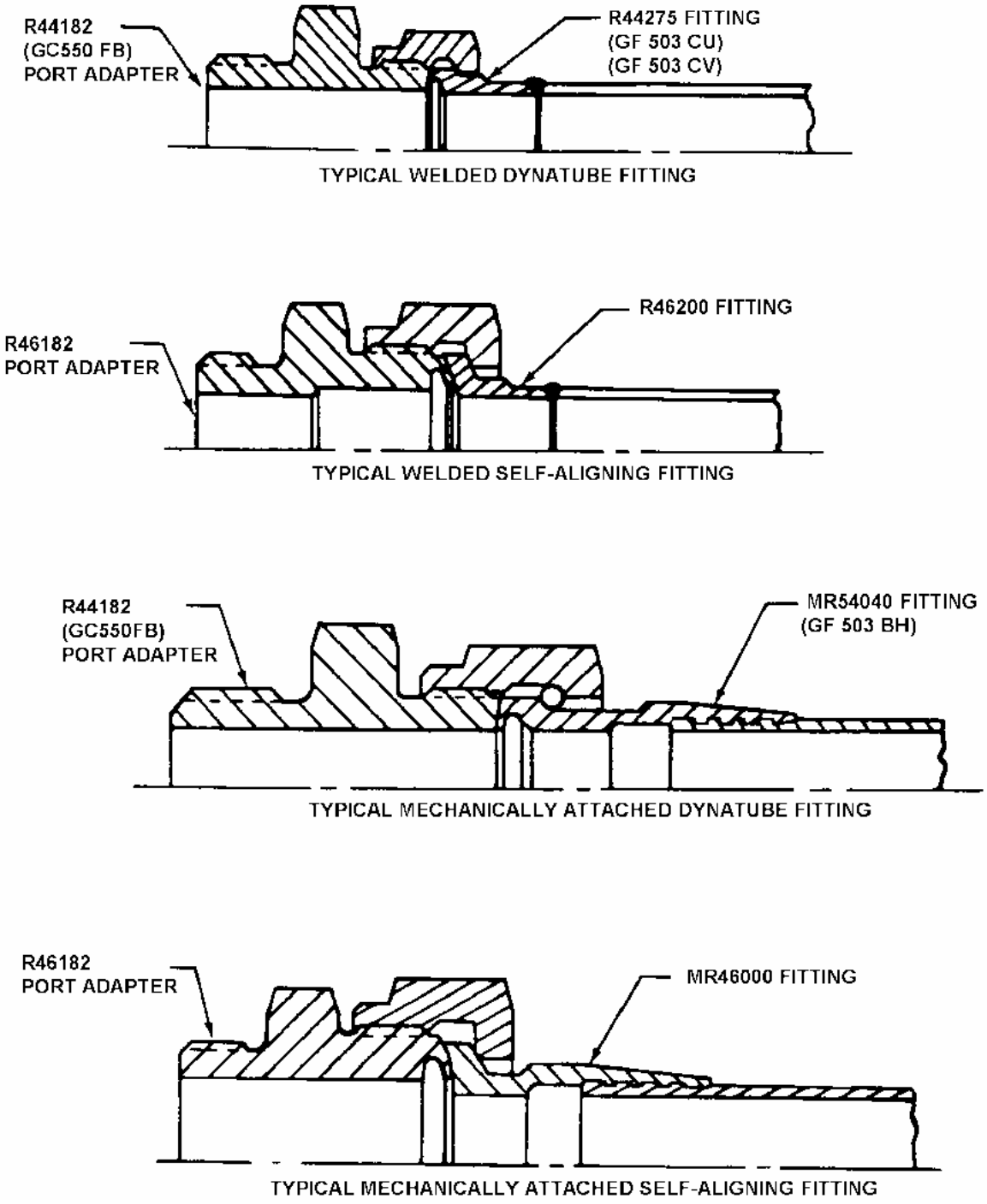


013022

Figure 22. High Pressure Self-Aligning Tube Fitting Dynamic Seal

Table 10. Self-Aligning Dynatube Fitting-Installation Torque

Fitting Size	Minimum (Note 1)		Normal (Note 1)		Maximum (Note 1)	
	Ft Lb	In Lb	Ft Lb	In Lb	Ft Lb	In Lb
-03	5	60	7	84	9	108
-04	10	120	12	144	14	168
-05	15	180	20	240	25	300
-06	25	300	30	360	35	420
-08	45	540	50	600	55	660
-10	60	720	65	780	70	840
-12	75	900	80	960	85	1020
-14	90	1080	95	1140	100	1200
-16	100	1200	120	1440	130	1560
-20	130	1560	140	1680	150	1800
-24	150	1800	160	1920	170	2040
Notes: 1. The torques listed are recommended for both high-strength stainless steel and titanium fittings.						



013023

Figure 23. Connecting Self-Aligning and Standard Dynatube Fittings

Table 11. Dynatube Fitting-Installation Torque

Fitting Size	Minimum (Note 1)		Normal (Note 1)		Maximum (Note 1)	
	Ft Lb	In Lb	Ft Lb	In Lb	Ft Lb	In Lb
-02	2	24	4	48	6	72
-03	5	60	7	84	9	108
-04	10	120	12	144	14	168
-05	10	120	13	156	16	192
-06	15	180	20	240	25	300
-07	21	252	26	312	31	372
-08	30	360	35	420	40	480
-09	33	396	39	468	45	540
-10	41	492	48	576	55	660
-12	50	720	60	780	70	840
-14	60	720	72	864	85	1020
-16	70	1260	82	1320	94	1380
-20	90	1080	105	1260	120	1440
-21	108	1296	124	1488	140	1680
-24	110	1320	130	1560	150	1800
-25	125	1500	145	1740	165	1980

Notes: 1. The torques listed are recommended for both high-strength stainless steel and titanium fittings.

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION AND MAINTENANCE

WIGGINS FITTINGS

Reference Material

None

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Wig-O-Flex Flexible Couplings, S305 and 6305 Series	2
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Record of Applicable Technical Directives

None

1. GENERAL.

2. This section provides information on Wiggins fittings, their assembly and installation. This section does not provide complete swaging instructions. If swaging equipment is available and manual swaging is used, refer to Table 1 for correct torque values. Paragraphs 17 and 19 provide information for checking and testing swaged joints.

3. DESCRIPTION.

4. WIG-O-FLEX FLEXIBLE COUPLINGS, S305 AND 6305 SERIES. Wig-O-Flex couplings are lightweight and are designed to join tube ends by swaging. The coupling is capable of 1/16-inch maximum tube misalignment, tube flexure of 4 degrees including angle, and minimum tube motion of 1/4 inch.

5. Full Coupling. The full coupling S305 or 6305 is used for joining swaged tubes from both ends (Figure 1); both ends of swaged tubes may flex.

6. Half Coupling. The half coupling S355 or 6355 is designed to use a boss WS61 as its body and accepts one swaged tube while maintaining its flexing capabilities (Figure 2).

7. Shape Fittings. Shape fittings (Figure 3) are tees, crosses, elbows, and wyes. Shape fittings have many of the same components, used in the full or half couplings, and work the same way as the full or half couplings. Shape fittings will incorporate one or more parts conforming to WS61 or WS62.

8. WIG-O-FLEX FLEXIBLE COUPLINGS, W700 AND W700DE SERIES. Wig-O-Flex couplings are lightweight and are designed to join tube ends by swaging. The coupling is capable of at least 1/16-inch tube misalignment, tube flexure of 4 degrees in any direction, and, provides positive seal with standard O-rings (Figure 4). In addition, it is electrically bounded; it requires no electrical grounding, so no lockwire installation is needed (Figure 5).

9. WIG-O-FLEX FLEXIBLE COUPLINGS, W900 SERIES. Wig-O-Flex couplings are lightweight, designed to join tube ends by swaging, and accommodate 4-degree tube flexure in any direction. The coupling provides positive seal with standard O-rings (Figure 6). It is electrically bonded and requires no lockwire installation (Figure 5) or specified torque.

10. MIN-O-MAL RIGID COUPLINGS, S8305 AND 8305 SERIES. Min-O-Mal couplings are lightweight and are designed to join tube ends rigidly by swaging. A Min-O-Mal coupling has a threaded body, a ferrule for swaging, and a threaded nut assembly for making connections. Min-O-Mal couplings do not allow tube flexure or movement.

11. Min-O-Mal Coupling Forms. Min-O-Mal couplings are manufactured in two forms, full and shape (Figures 7 and 8). Shape fittings are tees, crosses, elbows, and "Y"s. Shape fittings have many of the same components as the full coupling and work the same way as the full coupling. Shape couplings will incorporate one or more parts conforming to WS65 or WS190 fitting.

12. INSTALLING FITTINGS.

13. WIG-O-FLEX FLEXIBLE FITTINGS, 6300 AND 3600 SERIES. Fittings 6300 and 3600 series are designed for thin-wall swaged tubes 6300 and beaded tubes 3600 series with the MS33660 bead. These fittings have the following advantages:

a. Smaller size and lighter weight.

b. Can be hand-torqued.

c. Accommodates tube misalignment.

d. Offers radial movement.

e. Allows for expansion and contraction of tubes.

f. Available in aluminum or stainless steel.

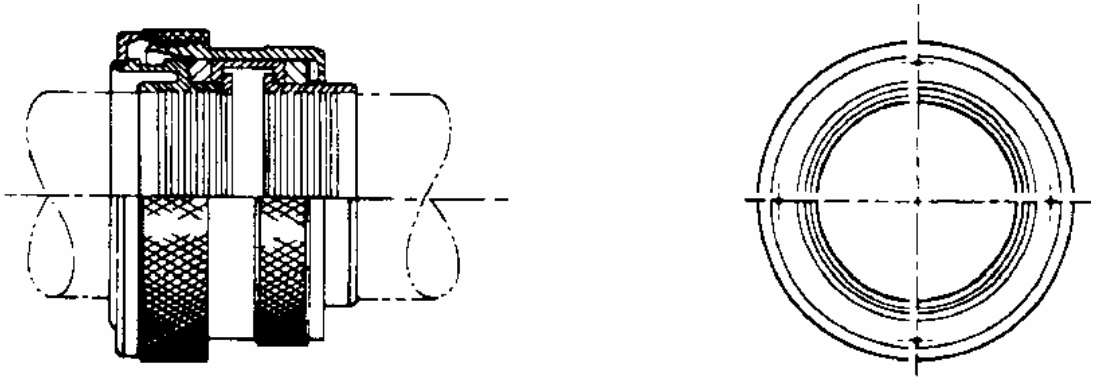
14. Installation Procedures. To install a fitting 6300 or 3600 series (Figure 9 and 10), proceed as follows:

a. Install body on one tube end and nut on other tube end (Figure 11). Body and nut will fit over ferrules.

b. Install metal washers on ferrules (Figure 12).

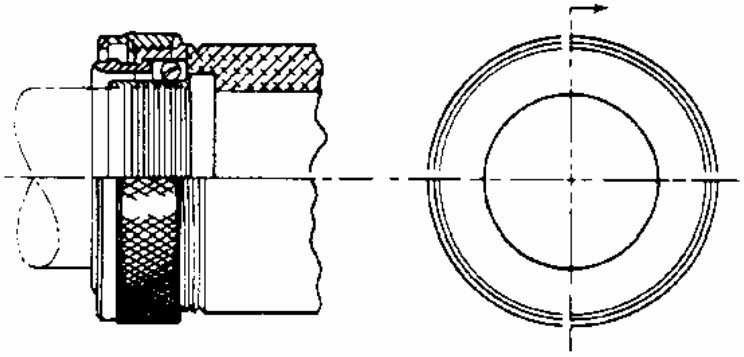
c. Install O-ring seal on each ferrule (Figure 13). Lubricate O-ring before installing.

d. Install snap retainer to enclose both tube ferrules (Figure 14).



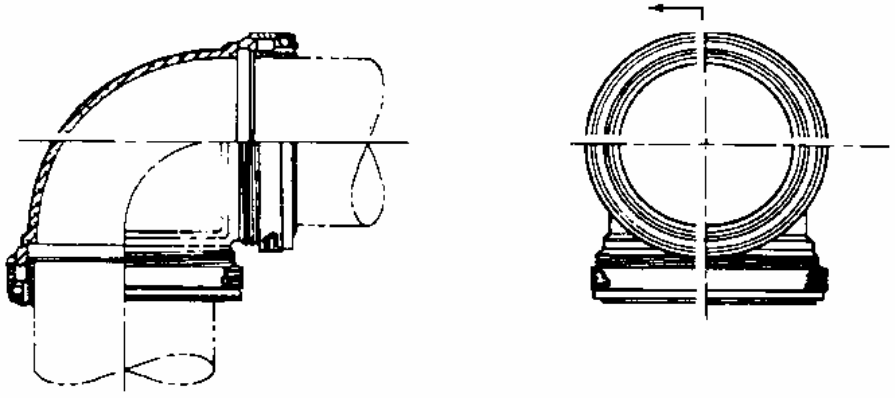
014001

Figure 1. Full Coupling, Type 6305 (Size)



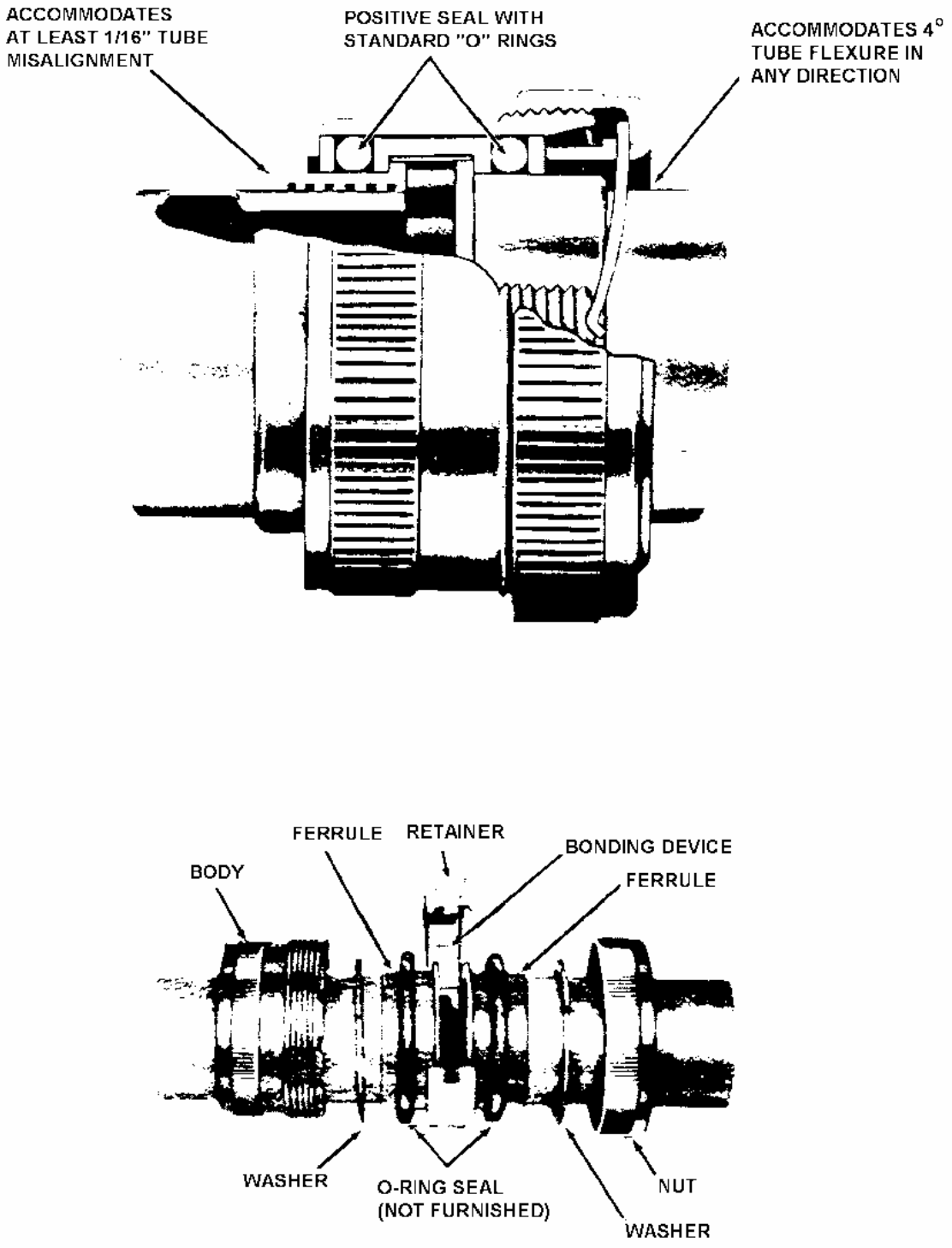
014002

Figure 2. Half Coupling, Type 6355 (Size)



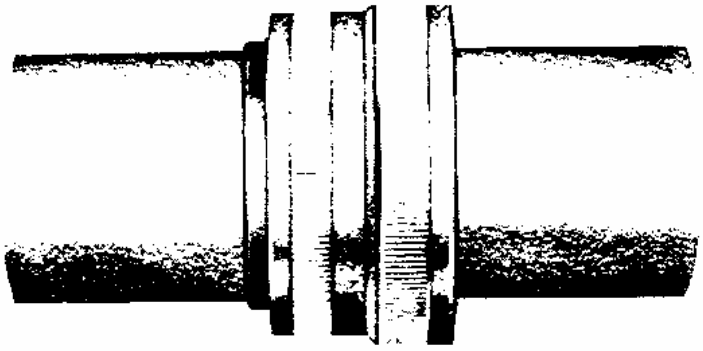
014003

Figure 3. Shape Fitting, Type 7351 (Size)

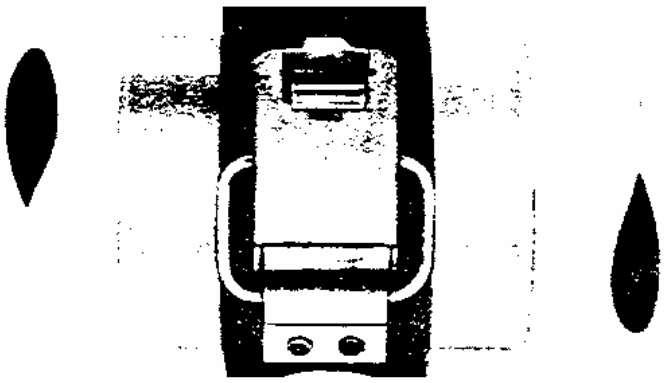


014004

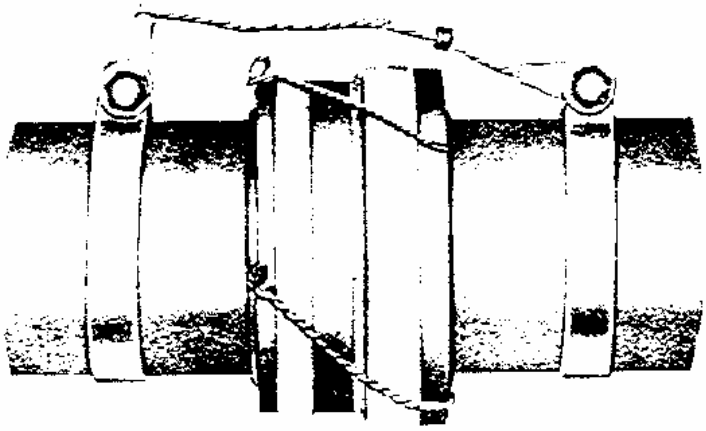
Figure 4. Wig-O-Flex Coupling, W700DE Series



NEW METHOD - W700DE SERIES



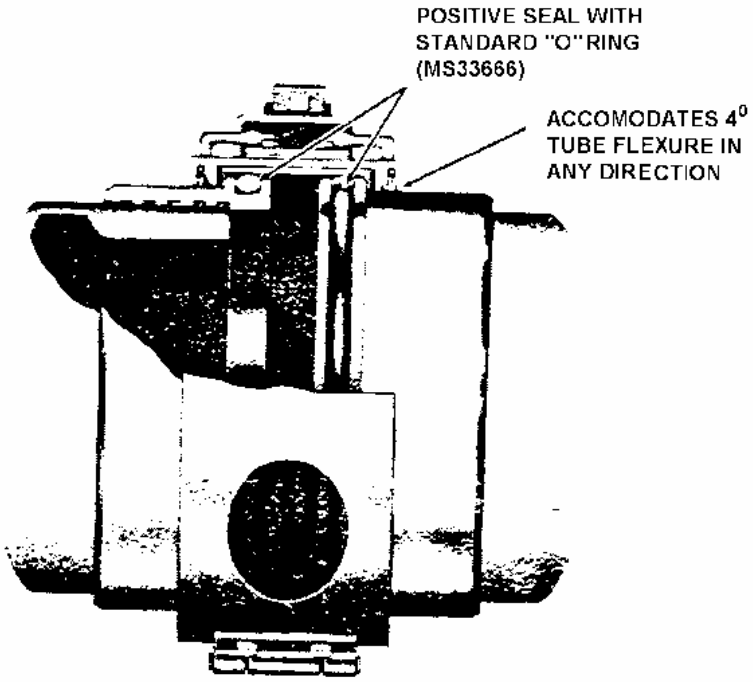
NEW METHOD - W900 SERIES

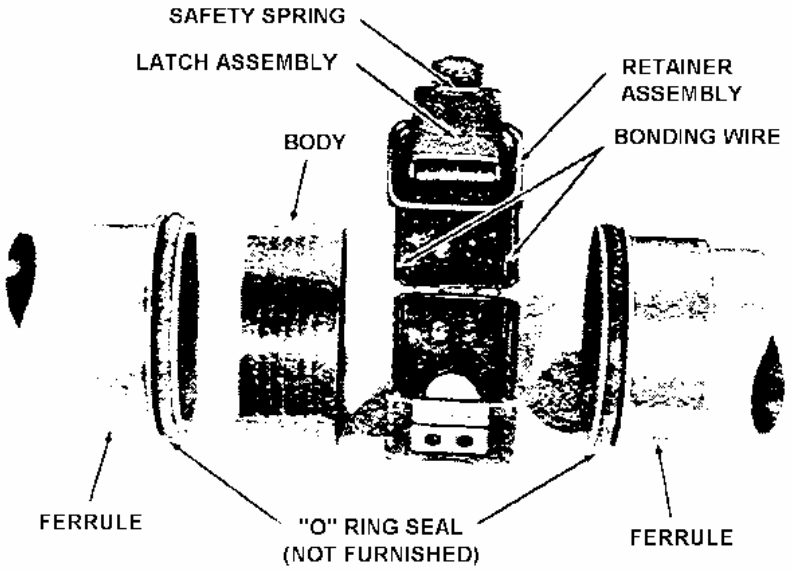


OLD METHOD - W700 SERIES

014005

Figure 5. Comparison of Old and New Methods of Installing Wig-O-Flex Couplings W700DE and W900





014006

Figure 6. Wig-O-Flex Couplings, W900 Series

NOTE

Two other vendors, Hydraflow and Aero Tube & Connector Company, manufacture flexible, beaded tube fittings similar to Wiggins 3600 series. The fittings manufacturer, manufacturer part number, and color of ferrules are shown below:

Vendor	Series Number	Ferrule Color
Aero Tube	LUW 360	Black
Hydraflow	12J36	Gold
Wiggins	3600	Grey

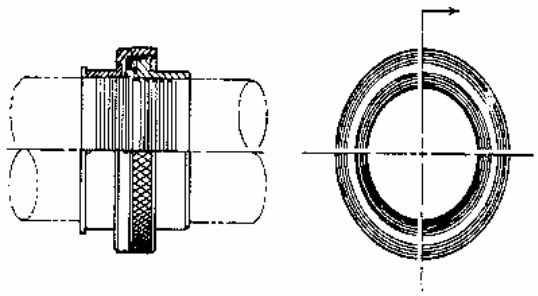
CAUTION

Ferrule halves from different vendors are not interchangeable. Do not combine ferrule halves of different colors.

e. Slide coupling body into position and engage threads (Figure 15).

f. Tighten nut onto body by hand (Figure 16). Handtight torque is sufficient.

15. WIG-O-FLEX FLEXIBLE FITTINGS, W700 AND W700DE SERIES. Installation procedure for W700 and W700DE fitting series is illustrated in Figure 17.



014007

Figure 7. Full Coupling, Type 8305 (Size)

16. WIG-O-FLEX FLEXIBLE FITTINGS, W900 SERIES. Installation procedure for W900 series fittings is illustrated in Figure 18.

17. INSPECTION.

18. Each swaged joint shall be checked for the following:

a. Ferrule is tight on tube.

b. Ferrule has not been damaged during swaging or handling.

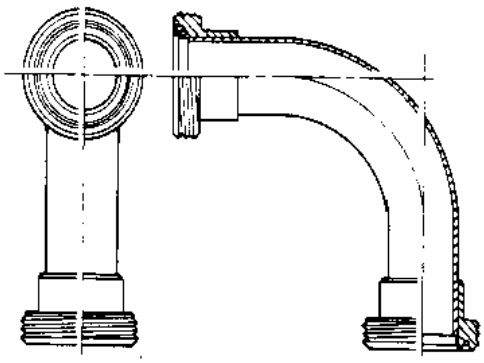
c. Ferrule sealing surface has not been disturbed by the split swage blocks. A raised, smooth, rounded welt is acceptable, provided it does not exceed .002 inch in height. On nonsealing surfaces, a height of .004 inch is acceptable.

d. Ferrule is square with the tube. Ferrule shall be within 1/2 degree for rigid ferrule 8300 series and for flexible ferrules 6300 series.

e. Tube has not extruded under the ferrule tube stop, causing it to protrude past face of ferrule.

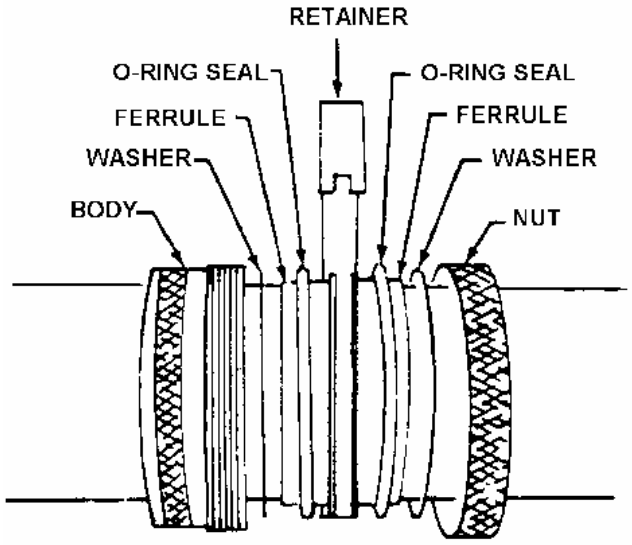
19. TESTING JOINT.

20. Pressure testing at operating or proof pressure is a means of checking quality of a swaged joint. A 100 percent leakage check of all swaged joints is recommended to prevent isolated failures. Periodic burst tests are also recommended to assure continual quality of swaged joints to pick up any gradual change in swaging techniques or tooling. In most installations, the tube will fail before the swaged joint fails, except where heavy wall-thickness tubing is used.



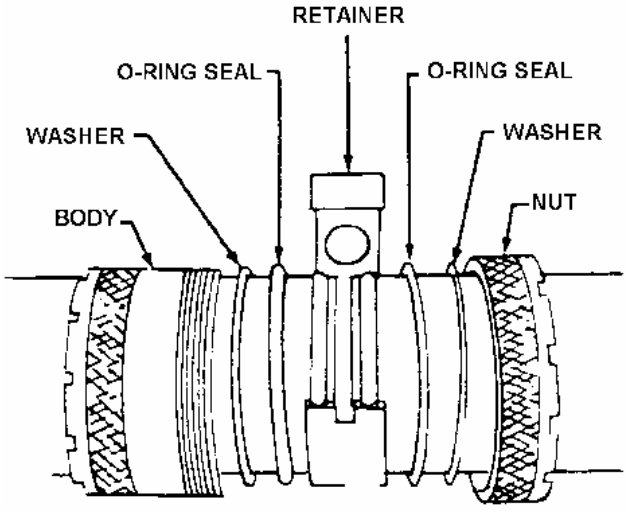
014008

Figure 8. Shape, Type 83514 (Size)



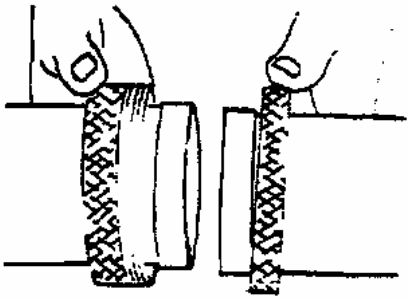
014009

Figure 9. Wig-O-Flex Connector, Type 6300 Series



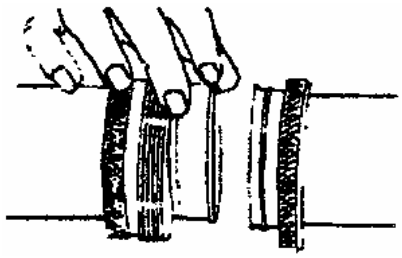
014010

Figure 10. Wig-O-Flex Connector, Type 3600 Series



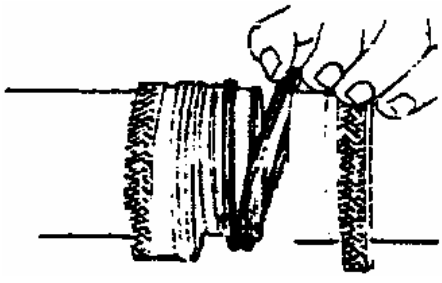
014011

Figure 11. Installing Body and Nut



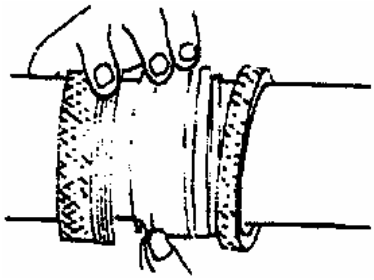
014012

Figure 12. Installing Washers



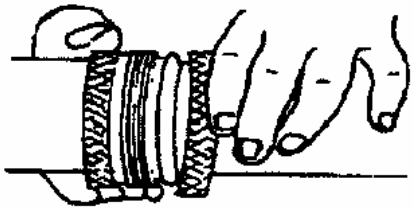
014013

Figure 13. Installing O-Ring Seals



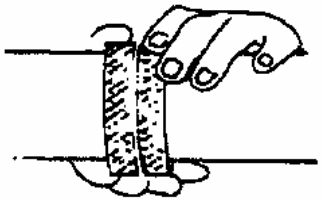
014014

Figure 14. Installing Snap Retainer



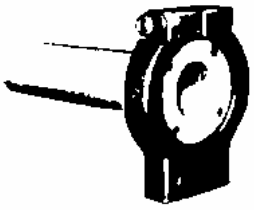
014015

Figure 15. Engaging Body and Nut



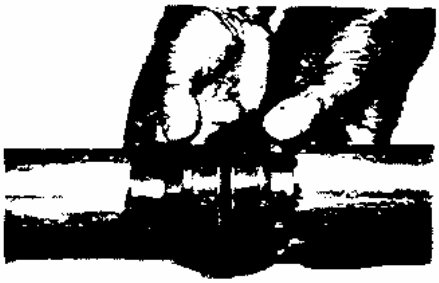
014016

Figure 16. Tightening Tube Connection



1. INSTALL TUBE AND FERRULE IN SWAGING DIE.

2. SWAGE FERRULE TO TUBE.

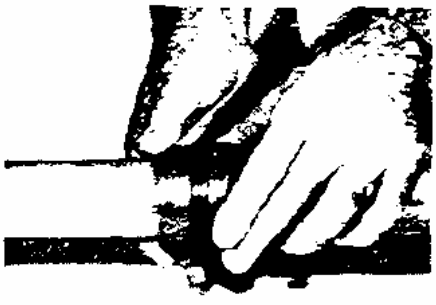


3. INSTALL BODY ON ONE TUBE END AND NUT ON THE OTHER TUBE END (BODY AND NUT WILL FIT OVER FERRULES).

4. INSTALL METAL WASHERS ON FERRULES.

5. INSTALL O-RING ON EACH FERRULE (LUBRICATE BEFORE INSTALLING).

6. INSTALL SNAP RETAINER ENCLOSING BOTH TUBE FERRULES.

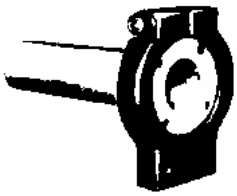


7. SLIDE COUPLING BODY INTO POSITION AND ENGAGE THREADS.

8. TIGHTEN BY HAND (HAND-TIGHT TORQUE IS SUFFICIENT).

014017

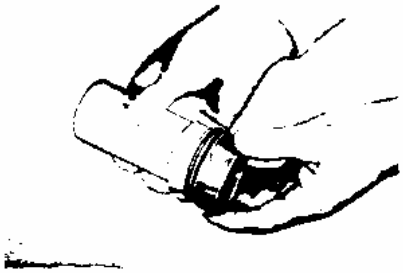
Figure 17. Installation Procedure for Wig-O-Flex W700 and W700DE Fittings



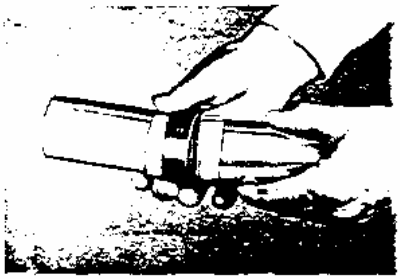
1. INSTALL TUBE AND FERRULE IN SWAGING DIE.

2. SWAGE FERRULE TO TUBE.

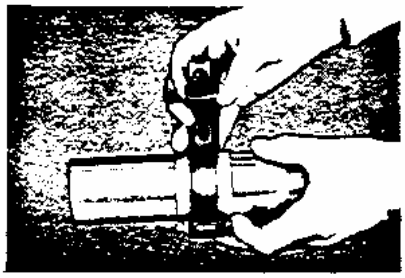
3. INSTALL O-RING ON EACH FERRULE (LUBRICATE BEFORE INSTALLING).



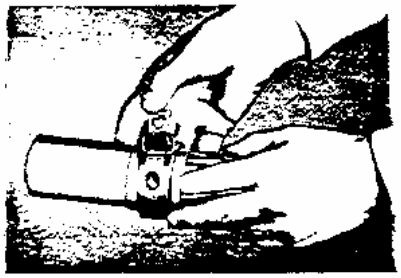
4. INSTALL BODY ON ONE FERRULE.



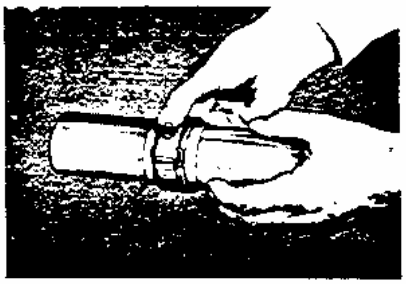
5. PULL BODY BACK OVER OTHER FERRULE.



6. INSTALL RETAINER ASSEMBLY ON BODY.



7. ENGAGE LATCH ASSEMBLY.



8. CLOSE INTO LOCKED POSITION.

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Figure 18. Installation Procedure for Wig-O-Flex W900 Series Fittings

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Table 1. Manual Torque Values (Inch Pounds)

Dash No.	Tube Size	Expander Assembly	5052-0 AL Alloy Tube			6061-T4 AL Alloy Tube			6061-T6 AL Alloy Tube			Steel
			Non-Anodized	Anodized	Wall Thickness	Non-Anodized	Anodized	Wall Thickness	Non-Anodized	Anodized	Wall Thickness	300 Series Stainless
-4	1/4	B8304-(Tube Wall)	2	4	.028	3	5	.028	5	7	.028	5
-5	5/16	B8305-(Tube Wall)	3	5	.028	4	6	.028	6	8	.028	10
-6	3/8	B8306-(Tube Wall)	4	6	.028	5	7	.028	7	9	.028	16
-8	1/2	B8308-(Tube Wall)	8	9	.028	9	10	.028	10	12	.028	28
-10	5/8	B8310-(Tube Wall)	13	14	.028	14	16	.028	17	20	.028	42
-12	3/4	B8312-(Tube Wall)	17	21	.028	21	23	.028	25	28	.028	54
-16	1	B8316-(Tube Wall)	30	34	.028	36	40	.028	46	50	.028	100
-20	1 1/4	B8320-(Tube Wall)	56	60	.028	62	70	.028	75	95	.028	160
-24	1 1/2	B8324-(Tube Wall)	100	110	.028	108	120	.028	120	145	.028	220
-28	1 3/4	B8328-(Tube Wall)	140	155	.028	150	165	.028	180	200	.028	300
-32	2	B8332-(Tube Wall)	200	220	.028	220	245	.028	265	300	.028	400
-36	2 1/4	B8336-(Tube Wall)	265	290	.028	295	330	.028	355	390	.028	550
-40	2 1/2	B8340-(Tube Wall)	310	340	.028	345	380	.028	415	455	.028	650
-44	2 3/4	B8344-(Tube Wall)	385	425	.035	425	475	.035	515	565	.035	
-48	3	B8348-(Tube Wall)	465	510	.035	515	565	.035	620	700	.035	
-56	3 1/2	B8356-(Tube Wall)	630	700	.035	700	775	.035	840	925	.035	
-64 (Note 1)	4	B8364-(Tube Wall)	840	925	.049	895	985	.035	1080	1180	.035	
-72 (Note 1)	4 1/2	B8372-(Tube Wall)	1000	1100	.035	1200	1250	.035	1320	1450	.035	
-80 (Note 1)	5	B8380-(Tube Wall)	1200	1370	.042	1400	1500	.049	1750	1800	.049	
-88 (Note 1)	5 1/2	B8388-(Tube Wall)	1450	1585	.049	1600	1750	.049	2000	2200	.049	

Notes: 1. Extreme care must be taken on very large sizes. Due to the high torque requirement, an ideal swage is very difficult to obtain. The figures shown are to be used as guides to establish a specific value for each particular application.

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION AND MAINTENANCE

SIERRACIN/HARRISON FLARELESS FITTINGS

Reference Material

Permaswage Fittings, Description and Maintenance WP011 00

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Preswaging Preparation	2
Post Swaging Inspection	4
Required Tools	2
Swaging Instructions	2
Sierracin/Harrison H-Fittings	12
Tube Assembly Repair with H-Fittings	15

Record of Applicable Technical Directives

None

1. GENERAL.

2. This section provides instructions for installing Harrison flareless sleeves, 35000 series, and Sierracin/Harrison H-fittings. Flareless sleeves, 35000 series, are swaged-by-hand swagers designed specifically for shipboard or vehicle repair of hydraulic tubing. When swaging equipment or other special tools are unavailable, an H-fitting may be used for urgent midline tube repair.

3. HARRISON FLARELESS SLEEVES, 35000 SERIES.

Materials Required

Specification or Part Number	Nomenclature
A-A-59281	Acetone

4. To attach Harrison flareless sleeves, 35000 series, to hydraulic tubing requires the use of hand swagers, model 5175 or 5720 (Figure 1). The power source is a self-contained, hand-operated hydraulic pump.

5. REQUIRED TOOLS.

6. Internal Tools. A drawbolt assembly which has all the basic internal tools is shown in Figure 2. The drawbolt assembly consists of a drawbolt, a urethane expander, a pair of seal rings, a bushing, and an anti-extrusion ring. The drawbolt assembly is inserted into tubing for swaging.

7. External Tools. The anvil, jaws, and retaining ring are classified as external tools and are shown in Figures 3 (model 5175) and 4 (model 5720). External tools enclose the tubing for swaging.

8. Special Tools. Special tools for 1/4 x .028-inch wall thickness tubing are shown in Table 1.

9. HAND SWAGERS, MODELS 5175 AND 5720.

10. Description. Hand swager tool kits, models 5175 and 5720, consist of tools classified as internal and external tools (Figures 2 and 3). Internal tools are used inside of tubing and external tools are used outside of tubing to be swaged. Internal and external tools are listed on Tables 2 (model 5175) and 3 (model 5720).

11. Operation. Hand swagers, models 5175 and 5720, attach flareless sleeves (series 35000) to tubing by swaging. To swage, the sleeve is placed on the tubing end; both the sleeve and tubing are slipped over the drawbolt assembly attached to the hydraulic cylinder. The external jaws are positioned around the tube sleeve and the retainer is placed over the jaws. When the cylinder is actuated, an expander compresses against the drawbolt and forces it out against the tubing. The expander swages the tubing into grooves at the bore of the sleeve. A completely swaged fitting assembly is shown in Figure 5. Model 5175 swages tubing sizes are from -4 through -08. Model 5720 swages tubing sizes are from -10 through -24.

12. PRESWAGING PREPARATION. After cutting tube to required length, tube ends shall be prepared as shown in Figure 6. The shortest recommend length from tube end to the start of tube bend radius is shown in Table 4.

NOTE

Countersinking shall not cause expansion of the tube end. Tube roundness must be maintained to accept internal tooling.

13. SWAGING INSTRUCTIONS. Swaging instructions are described in the following steps:

WARNING

Do not stand in direct line with drawbolt assembly. If wrong swage pressure is accidentally applied, a drawbolt failure is possible.

CAUTION

Make sure outside surface in the area of sleeve is free of dirt, lubricant, and scratches.

Do not activate swaging cylinder with drawbolt assembly in swager unless tube sleeve, jaws, and retainer ring are in position.

Do not exceed recommended swaging pressure (Tables 5 and 6).

NOTE

Operation of swager, model 5720 is identical to model 5175, except the 5720 retainer ring is secured in place by tightening two nuts prior to swaging. Loosen nuts to free retainer ring after swaging.

a. Check tube size and wall thickness of tube.

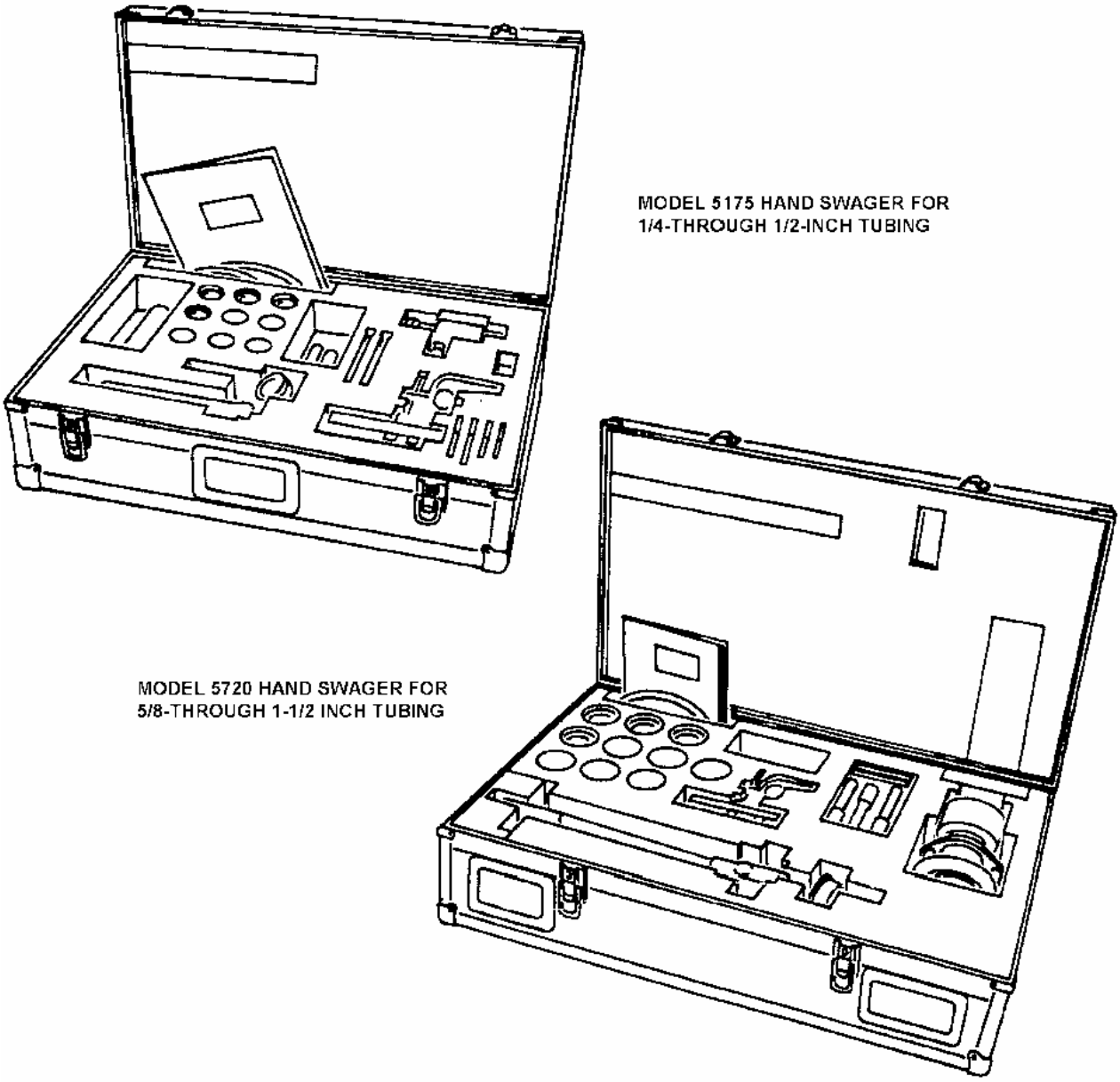

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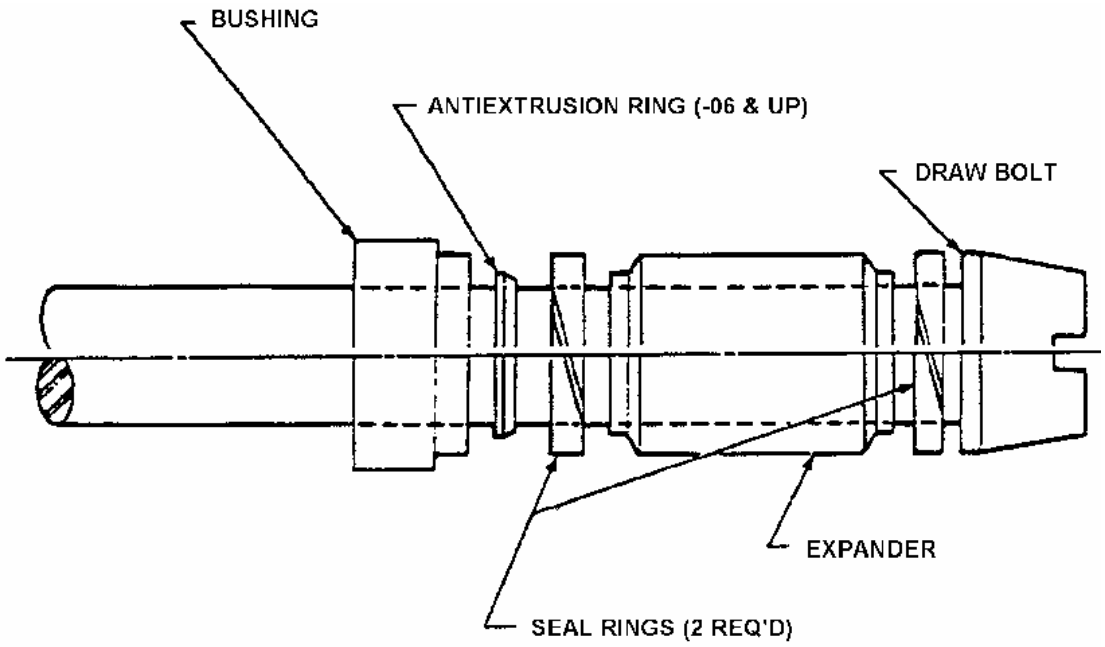
Figure 1. Sierracin/Harrison Hand Swager



015002

Figure 2. Drawbolt Assembly

b. Use tube size and wall thickness from step a to select the correct tools from Tables 2 or 3. See Figure 7 for the required swaging tools.

Acetone, A-A-59281 **14**

c. Make sure all mating surfaces are free of dirt and foreign objects before installation. Clean mating surfaces with acetone.

d. Remove cap ring from swager head assembly and insert adapter and anvil head assembly (Figure 8).

e. Install cap ring on head assembly finger-tight.

f. Screw drawbolt assembly into adapter through bore of anvil. Tighten drawbolt finger-tight. Make sure drawbolt bottoms in adapter (Figure 9).

g. Lubricate expander Outer Diameter (OD) and seal rings every third swage. Do not use excessive lubricant.

h. Install flareless sleeve (Harrison 35000 series) over tube, and tube with sleeve over drawbolt assembly. Push tube into anvil until sleeve and tube seat against their respective stops. Make sure jaws and retaining ring mating surfaces are free of lubricant and dirt.

i. Install jaws around anvil, tube, and sleeve (Figure 10).

j. Position retaining ring over jaws (Figure 11).

NOTE

If only one end of tube is accessible for swaging, place retaining ring over tube before installing drawbolt in tube.

k. Close pump valve.

l. With one hand holding swager head assembly (Figure 12), pump with other hand to required pressure (Table 5 or 6).

m. Release pressure by opening pump valve.

n. Remove retaining ring, jaws and swaged tube.

14. POST SWAGING INSPECTION. Post swage inspection consists of visual and mechanical checking of swaged grooves.

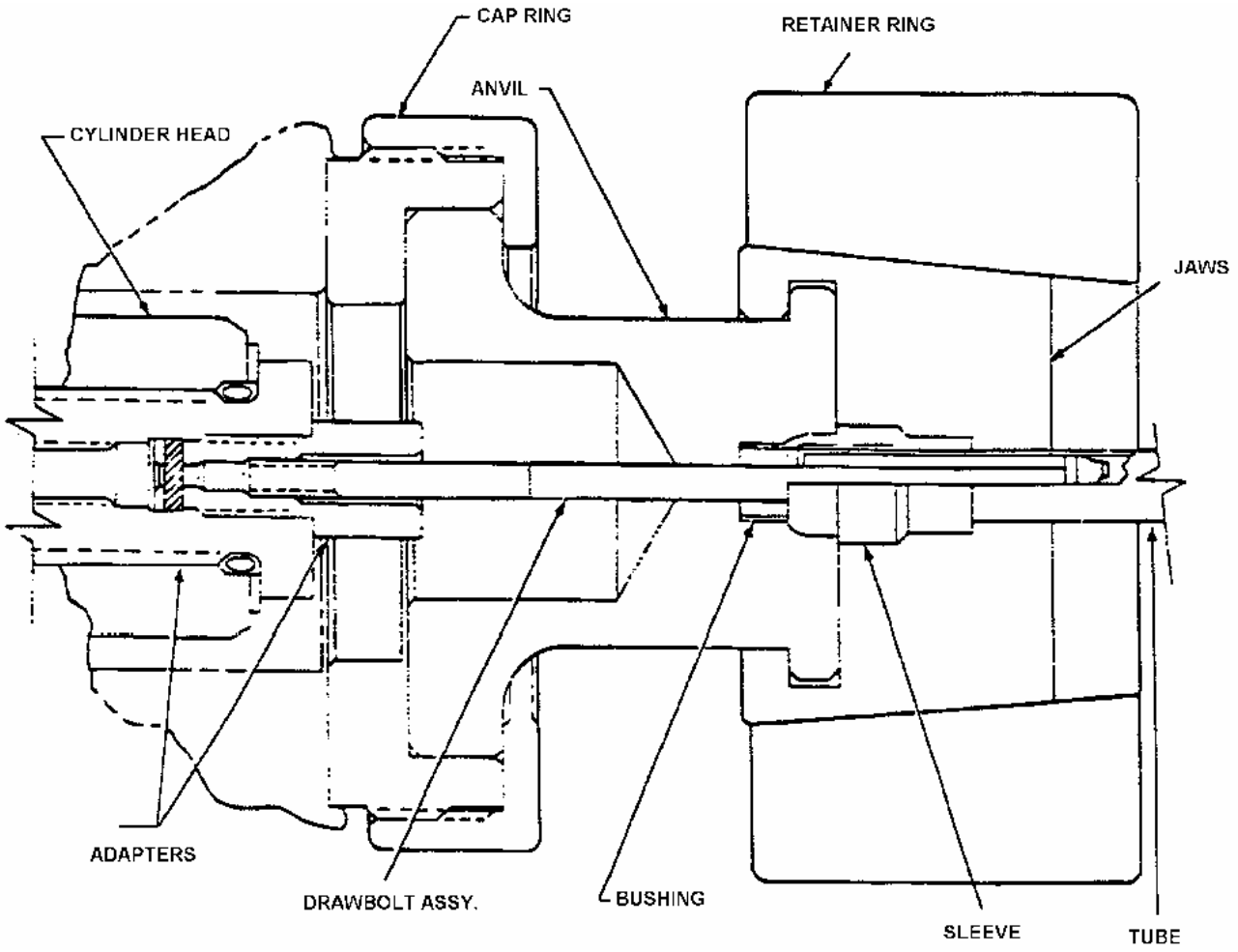


Figure 3. Cross Section View of Swager Assembly, Model 5175

15. Visual Checking. Figure 13 is a guide for evaluating the swage visually. A visual check is only a preliminary check of the swage. For the swage to be considered adequate it must pass the following method of mechanical checking the swage.

16. Mechanical Checking. Mechanical checking of the swage must be performed. A proof pressure test is not sufficient to assure the fitting has been adequately swaged. A line with a fitting inadequately swaged may pass the proof pressure test but develop a leak, after installation, due to aircraft vibration. Use Mueller gages, inside micrometers, dial gages, profilometers, or groove micrometers to check the amount of swage or tube expansion in the grooves. To determine acceptable swage measurements, twice the tube wall thickness is subtracted from groove diameters. Because the groove farthest from tube end is deepest, it is sufficient to measure this area only. If this area is adequately swaged, the other grooves will be satisfactory. Acceptable swaged groove measurements are shown in Table 7.

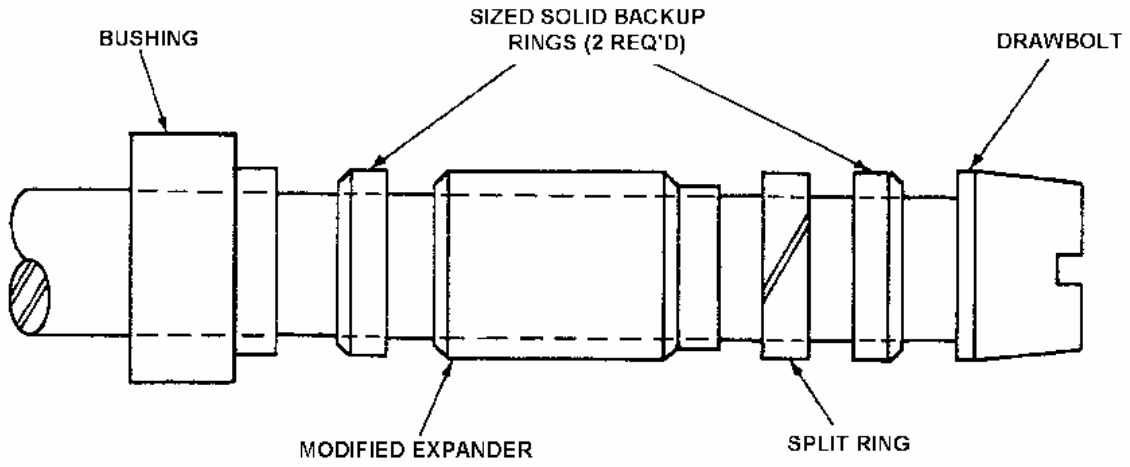
17. Measuring Swaged Grooves With a Mueller Gage. To measure swaged grooves with a Mueller gage (Figure 14), proceed as follows:

a. Loosen two Allen setscrews on side of Mueller gage.

b. Calculate nominal Inner Diameter (ID) of swaged tube by subtracting twice the wall thickness from OD of swaged tube.

Example: tube with 1.00-inch OD and
.049-inch wall thickness.
ID = 1.00 - (2 X .049)
1.00 = .098
= .902

Table 1. Special Tools for 1/4 x .028-Inch Wall Thickness Tubing



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Tube Size	Wall Thickness	Drawbolt Part No.	Expander Part No.	Split Ring Part No. (1 Req'd)	Bushing Part No.	Backup Ring Part No. (2 Req'd)
-04 (1/4 inch)	.028	5642-3028	6621-04028	5937-04028	6150-04028	5835-4-040XXX (Note 1)
Example: -04 x .028 inch	Length .188 through .203 inch		Part No. of Complete Set 5835-3-04028 (14 each)		Part No. of Backup Ring 5835-4-040188 (2 each) -040190 (2 each) -040192 (2 each) -040194 (2 each) -040196 (2 each) -040198 (2 each) -040200 (2 each) Last 3 digits indicate diameter	

Notes:
1. The use of solid backup rings reduces the clearance between the internal tooling and the tube ID which minimizes extrusion when swaging. When selecting a pair of backup rings for a particular tube, use the largest diameter backup ring that will enter the tube easily.
2. To cover the variations of the tube ID tolerances, backup rings in increments of .002 inch should be on hand. A complete set of backups per tube ID is recommended.

Table 2. Hand Swager 5175 Tooling Chart

Flareless Sleeve (35000 Series)				
Tube Size (Note 1)	**Wall Thickness (Note 2)**	**Drawbolt Part No.**	**Expander Part No.**	**Seal Ring Part No. (2 Req'd)**
1/4 (-04)	.016 through .020	5642-3016 through 5642-3035	5944-04016 through 5944-04020	5937-04016 through 5937-04020
5/16 (-05)	.016 through .035	5643-3016 through 5643-3035	5944-05016 through 5944-05035	5937-05016 through 5937-05035
3/8 (-06)	.016 through .035	5902-3016 through 5902-3035	5944-06016 through 5944-06035	5937-06016 through 5937-06035
1/2 (-08)	.016 through .049	5645-3016 through 5645-3049	5944-08016 through 5944-08049	5937-08016 through 5937-08049
5/8 (-10)	.016 through .049	5646-3016 through 5646-3049	5944-10016 through 5944-10049	5937-10016 through 5937-10049
3/4 (-12)	.016 through .049	5647-3016 through 5647-3049	5944-12016 through 5944-12049	5937-12016 through 5937-12049
1 (-16)	.016 through .065	5986-3016 through 5986-3065	5944-16016 through 5944-16065	5937-16016 through 5937-16065
1 1/4 (-20)	.016 through .072	5649-3016 through 5649-3072	5944-20016 through 5944-20072	5937-20016 through 5937-20072
1 1/2 (-24)	.016 through .076	5650-3016 through 5650-3076	5944-24016 through 5944-24076	5937-24016 through 5937-24076

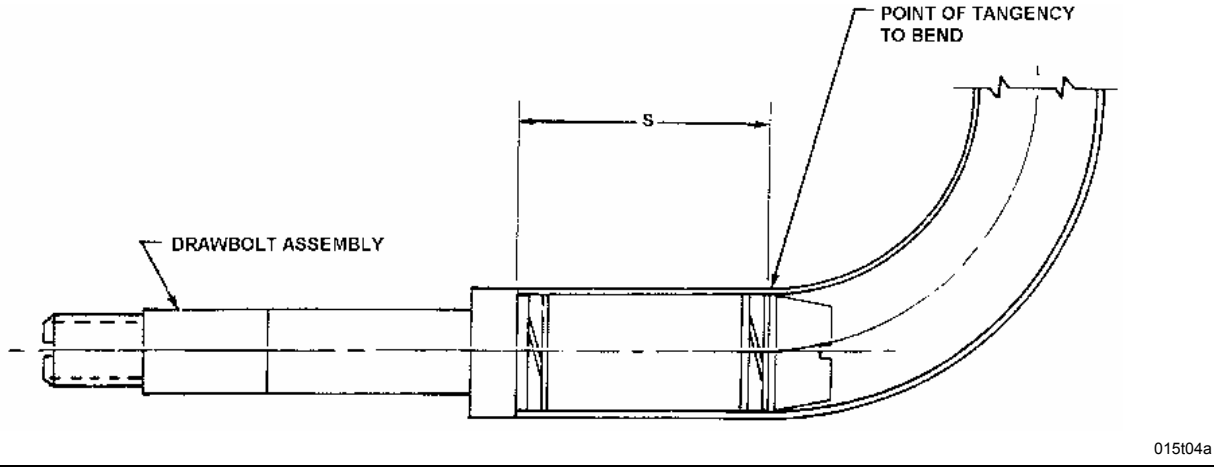
Notes: 1. All dimensions are in inches.
2. Special tool is required for 1/4 X .028-inch wall thickness tubing (Table 1).

Table 3. Hand Swager 5720 Tooling Chart

Flareless Sleeve (35000 Series)						
Bushing Part No.	**Anti-Extrusion Ring Part No.**	**Anvil Part No.**	**Jaws (Pair) Part No.**	**Adapter (Notes 1 and 2)**	**Wall Thickness (Note 3)**	**Tube Size (Note 4)**
6150-04016 through 6150-04035	None Req'd	5284-2	5772	5329 and 5930	.016 through .020	1/4 (-04)
6150-05016 through 6150-05035	None Req'd	5285-2	5773	5329 and 5930	.016 through .035	5/16 (-05)
6150-06016 through 6150-06035	5942-06	5286-2	5774	5930	.016 through .035	3/8 (-06)
6150-08016 through 6150-08049	5942-08	5288-2	5775	5930	.016 through .049	1/2 (-08)
6150-10016 through 6150-10049	5942-10	5310-2	5776	5307 and 5990	.016 through .049	5/8 (-10)
6150-12016 through 6150-12049	5942-12	5311-2	5777	5307 and 5990	.016 through .049	3/4 (-12)
6150-16016 through 6150-16065	5942-16	5312-2	5778	5990	.016 through .065	1 (-16)
6150-20016 through 6150-20072	5942-20	5313-2	5779	5990	.016 through .072	1 1/4 (-20)
6150-24016 through 6150-24076	5942-24	5314-2	5606	5990	.016 through .076	1 1/2 (-24)

Notes:
1. Adapter 5990 is integral with hydraulic swaging cylinder and does not have to be removed.
2. Adapter 5930 is integral with hydraulic swaging cylinder and does not have to be removed.
3. All dimensions are in inches.
4. Special tool is required for 1/4 X .028-inch wall thickness tubing (Table 1).

Table 4. Minimum Straight Tube End Length



Minimum Straight Tube End Length									
Size	**-04**	**-05**	**-06**	**-08**	**-10**	**-12**	**-16**	**-20**	**-24**
S Dimensions	.95	.99	1.00	1.13	1.43	1.54	1.19	1.05	1.24

Notes: 1. All dimensions are in inches.

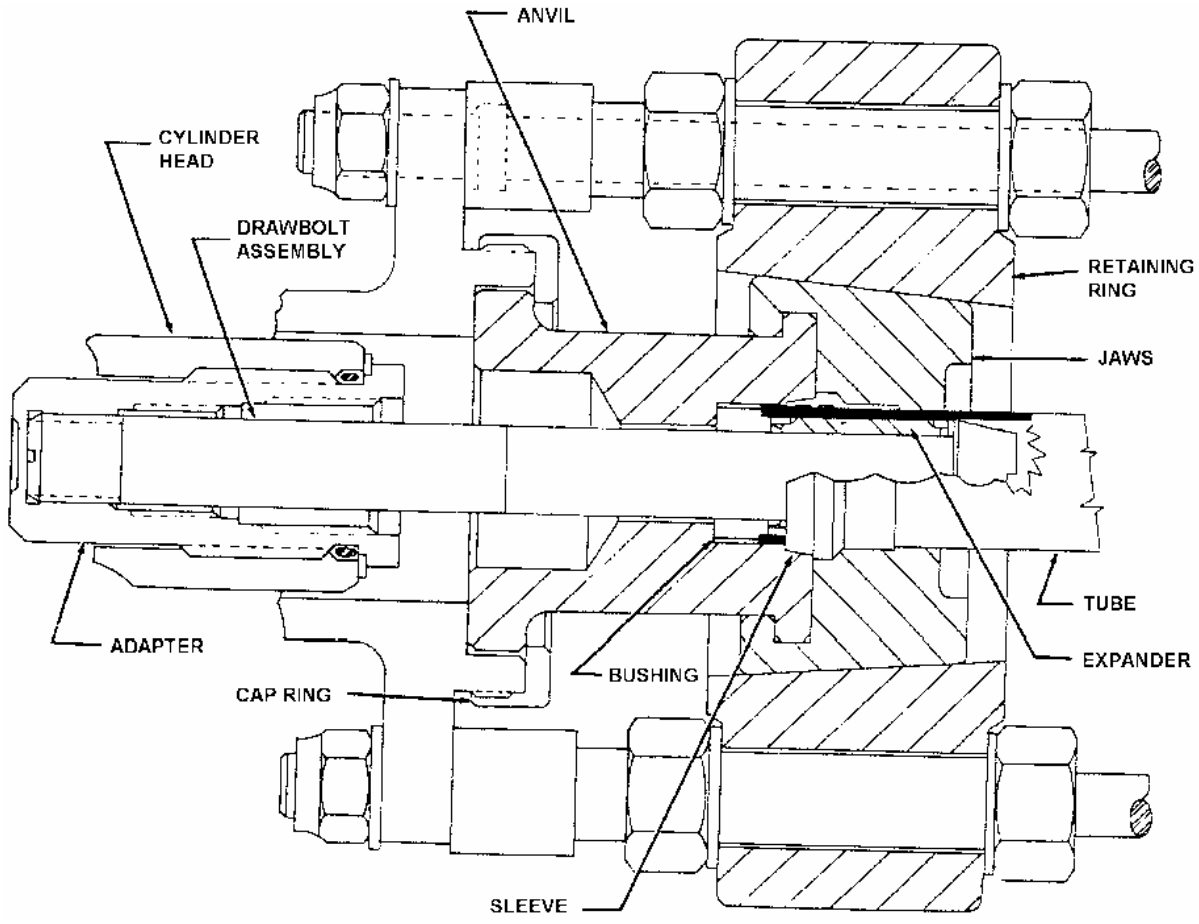


Figure 4. Cross Section View of Swager Assembly, Model 5720

Table 5. Recommended Swage Pressures - Swager 5175

Pressures in psig for 2-Groove Sleeves							
Tube Size	Wall Thickness (Note 2)	Aluminum 5052-0	Aluminum 6161-T6	CRES (Note 3) 304 & 321 Annealed	CRES (Note 3) 304 (1/8 HARD)	CRES (Note 3) 21-6-9	Max. Safe Pressure (Note 1)
		WW-T-700/4	AMS-T-7081 WW-T-700/6	MIL-T-8504 AMS 5556 AMS 5557	AMS-T-6845	BMS7-185 CO8-1173	
-04	.016	65		395	415	475	580
	.020	80		460	475	500	
	.028	200	200	450			
	.035	220	220				
-05	.016	80		440		700	1050
	.020	100		480	-600	750	
	.028		350	600	750		
	.035	310	450	750			
-06	.020	125		600	950	1120	1900
	.022	140		615	880	1230	
	.028	185	400	870	1150	1550	
	.035	255	500	940	1500		
	.042			1120			
-08	.020			950	1230	1735	2700
	.026	230		860	1400	2070	
	.028	240	650	920	1585	2230	
	.035	325	950	1190	2070		
	.042			1565	2375		
	.049			2070			

CAUTION

Do not exceed more than 5 percent of recommended pressure to achieve proper groove depth as required in Table 7.

Notes:
1. Maximum safe pressures are used for manufacturer's tool checkout and are not to be used for swaging.
2. All dimensions are in inches.
3. Corrosion-Resistant Steel (CRES).

Table 6. Recommended Swage Pressures - Swager 5720

Pressures in psig for 2-Groove Sleeves							
Tube Size	Wall Thickness (Note 2)	Aluminum 5052-0	Aluminum 6161-T6	CRES (Note 3) 304 & 321 Annealed	CRES (Note 3) 304 (1/8 HARD)	CRES (Note 3) 21-6-9	Max. Safe Pressure (Note 1)
		WW-T-700/4	AMS-T-7081 WW-T-700/6	MIL-T-8504 AMS 5556 AMS 5557	AMS-T-6845	BMS7-185 CO8-1173	
-10	.020		220	335	495	680	1650
	.028		325	385	620	880	
	.033	125		500	740	850	
	.035	140	375	595	875	1230	
	.042			700	1010		
-12	.020	90		400	590	820	2500
	.028			635	940		
	.035	220	600	880	1295		
	.039			1010	1600		
	.042	310		1120	1550	2200	
	.058			1350	1600		
-16	.028			1100	1275	1520	5000
	.035	320	950	1650	1630	1940	
	.042			1320	1950	2320	
	.049	390		1560	2290	2730	
	.052			1665	2455	3050	
	.058			1860	2730	3250	
	.065		700	1935	3050		
	.083			1980			
-20	.035	400	1200	1650	2380	3050	6500
	.042			1935	2820		
	.049			2220	3260		
	.058			2510	3700		
	.065						
	.083						

Table 6. Recommended Swage Pressures - Swager 5720 (Cont)

Pressures in psig for 2-Groove Sleeves							
Tube Size	Wall Thickness (Note 2)	Aluminum 5052-0	Aluminum 6161-T6	CRES (Note 3) 304 & 321 Annealed	CRES (Note 3) 304 (1/8 HARD)	CRES (Note 3) 21-6-9	Max. Safe Pressure (Note 1)
		WW-T-700/4	AMS-T-7081 WW-T-700/6	MIL-T-8504 AMS 5556 AMS 5557	AMS-T-6845	BMS7-185 CO8-1173	
-24	.028		790	2000			7000
	.035	360	1100	2160	3600		
	.042			2310	3390		
	.049	600	1400	2485	3650		
	.058			2730	4010		
	.065			2900	4270		
	.083						

CAUTION

Do not exceed more than 5 percent of recommended pressure to achieve proper groove depth as required in Table 7.

Notes:
1. Maximum safe pressures are used for manufacturer's tool checkout and are not to be used for swaging.
2. All dimensions are in inches.
3. Corrosion-Resistant Steel (CRES).

c. Adjust jaws with a micrometer by sliding the lower jaw up and down to .050 ± .010 inch larger than nominal ID obtained in step b. The thumbscrew on top lever is for fine adjustment. After adjustment is made, lock thumbscrew with locknut.

d. Close gage jaws by lifting thumb lever enough to insert jaw rips into tube 1/8 inch to 1/4 inch behind groove as shown in Table 7. When in position, release thumb lever.

e. Loosen black thumbscrew on side of dial gage to enable dial face to turn. Keep jaws parallel with tubing and turn dial ring to zero under pointer.

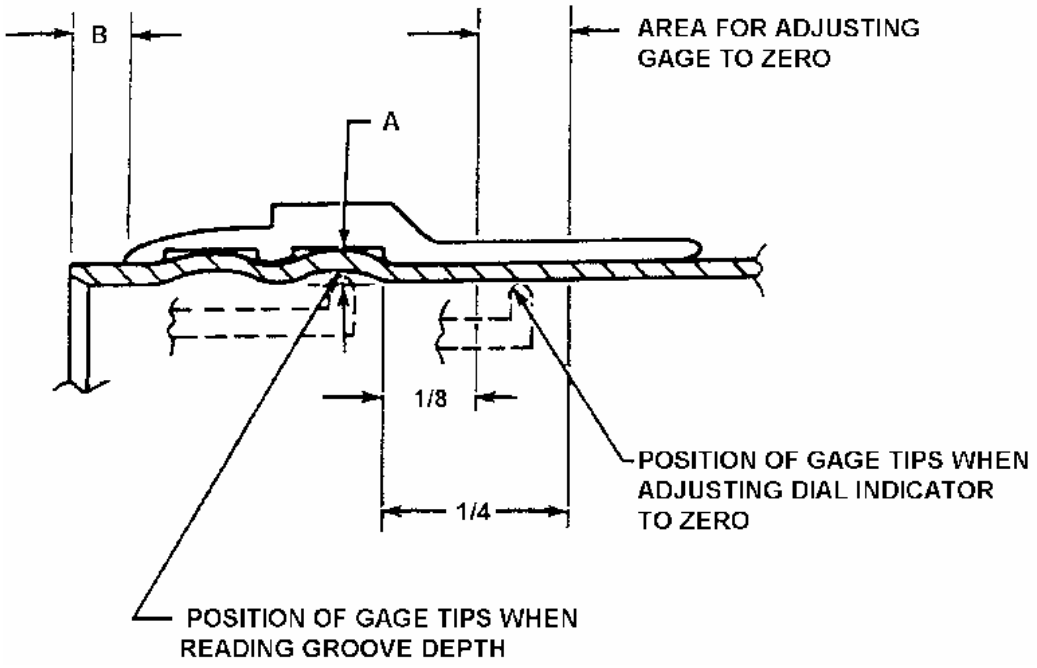
f. Keep jaws parallel with tube and slowly draw Mueller gage toward end of tube until jaw tips fall into swaged groove farthest in the tube.

g. Record dial gage reading. This reading is the total ID expansion into groove (twice actual expansion into sleeve groove). Table 7 shows acceptable depth readings for swaged grooves.

18. SIERRACIN/HARRISON H-FITTINGS.

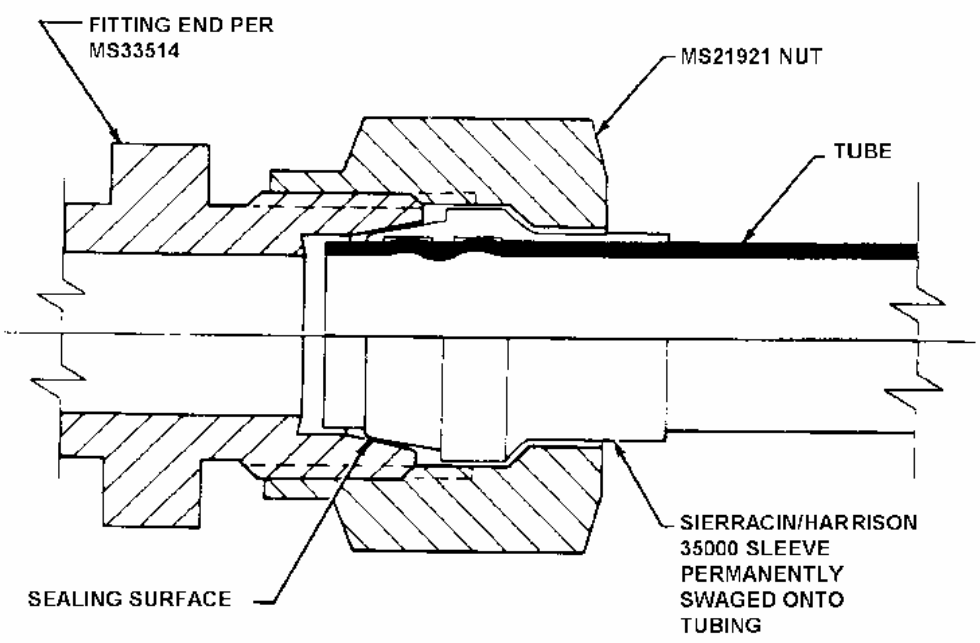
19. Sierracin/Harrison H-fittings are used for midline tube repair when swaging equipment or other specialized tools are unavailable, or when urgent repair is needed.

Table 7. Measuring Swaged Grooves



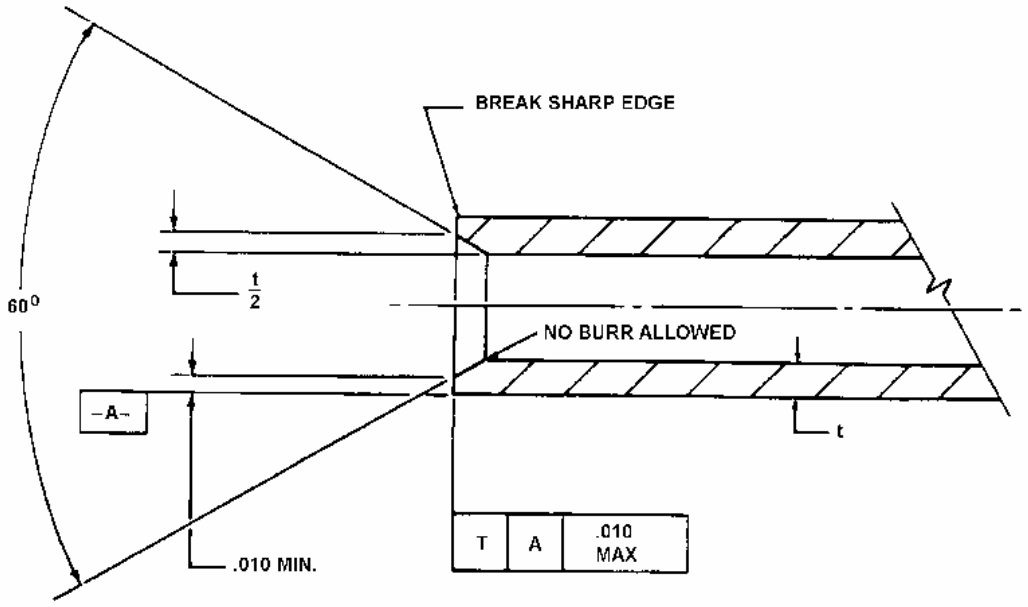
Required Measurement			
Swage Groove Depth Limits			"B" Tube Length Out of Sleeve ±.010
Size	Depth 2A		
	Min.	Max.	
-04	.020	.032	.079
-05	.020	.032	.095
-06	.020	.032	.098
-08	.020	.032	.100
-10	.022	.034	.140
-12	.026	.038	.140
-16	.028	.040	.202
-20	.032	.046	.200
-24	.032	.047	.275

Notes: 1. All dimensions are in inches.



015005

Figure 5. Swaged Fitting Assembly



015006

Figure 6. Tube End Preparation

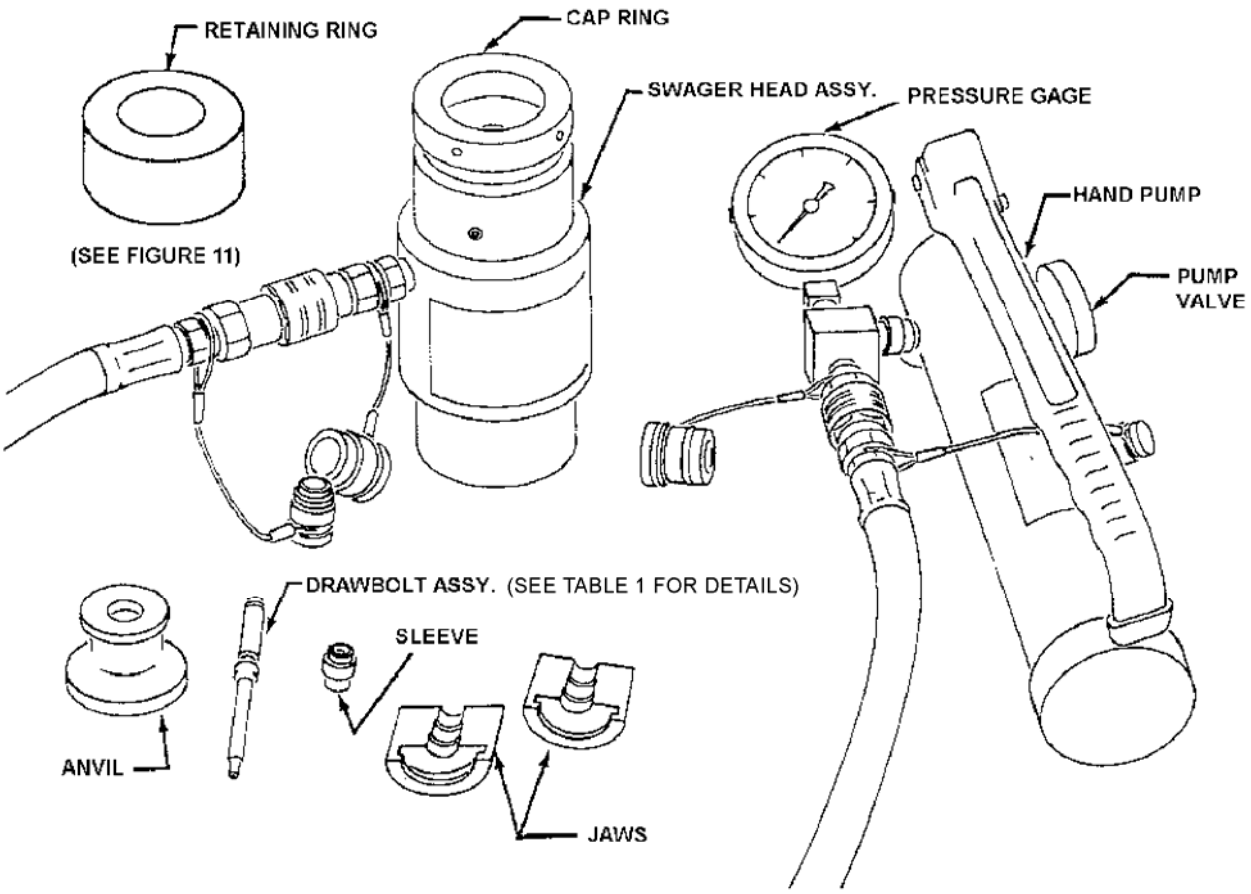


Figure 7. Swaging Tools

20. TUBE ASSEMBLY REPAIR WITH H-FITTINGS. Tube assembly repairs utilizing H-fittings are permanent repairs (Figure 15). In pressure ratings up to 3000 psi for tube OD sizes 1/4 through 1 inch, H-fittings may be used on any tubing materials (Table 8), provided that the wall thickness of selected tubing has the appropriate pressure rating or is greater than the replaced tubing.

NOTE

Although the H-fitting is considered a permanent repair, tube assemblies so repaired may be replaced/duplicated, for weight considerations, at the discretion of the maintenance activity.

21. The repair of tube or tube assemblies with H-fittings consists of the following basic operations:

a. Tube cutting.

b. Tube deburring.

c. Tube preparation.

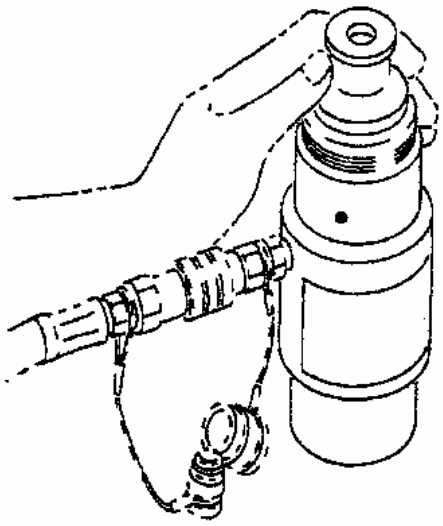
d. H-fitting installation.

22. <u>Tube Cutting.</u> When cutting tubing, the objective is to produce a square end, free from burrs. Tubing shall be cut with a standard tube cutter (Figure 16), or the Permaswage chipless cutter described in WP011 00. To cut tubing, proceed as follows:

CAUTION

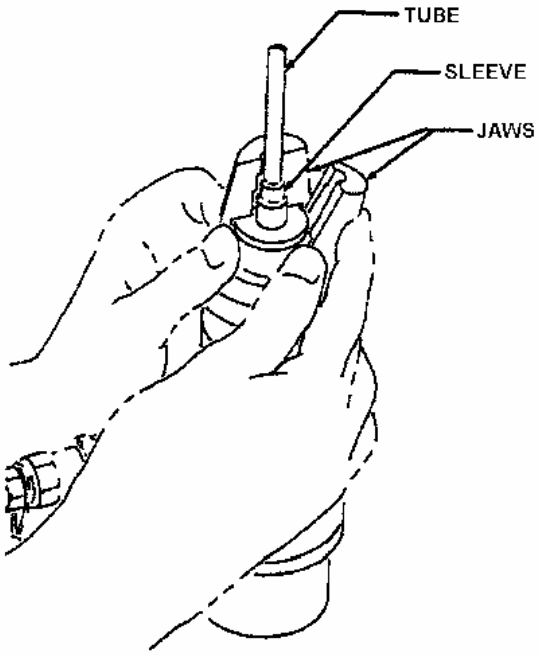
Maximum allowable gap between tube ends is .250 inch (Figure 17).

a. Place tube in cutter with cutting wheel at point where cut is to be made.



015008

Figure 8. Installing Anvil



015010

Figure 10. Installing Jaws

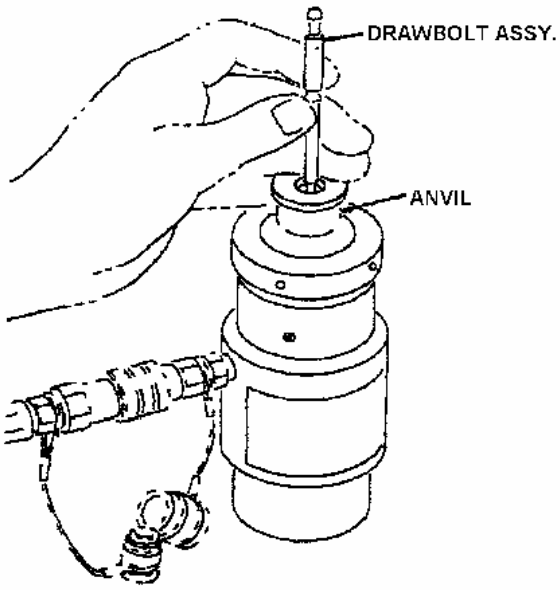


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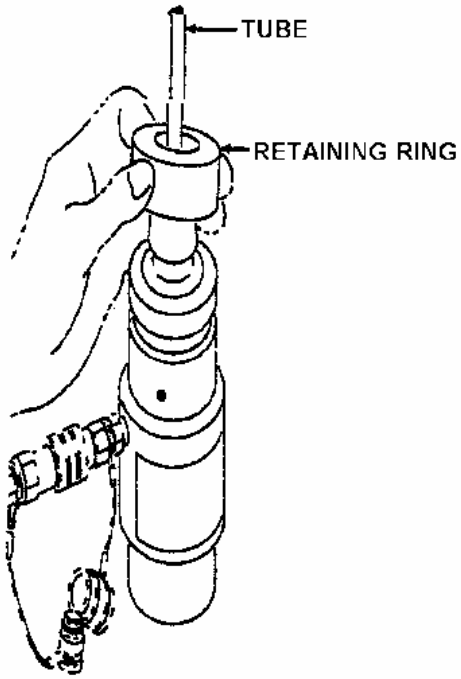
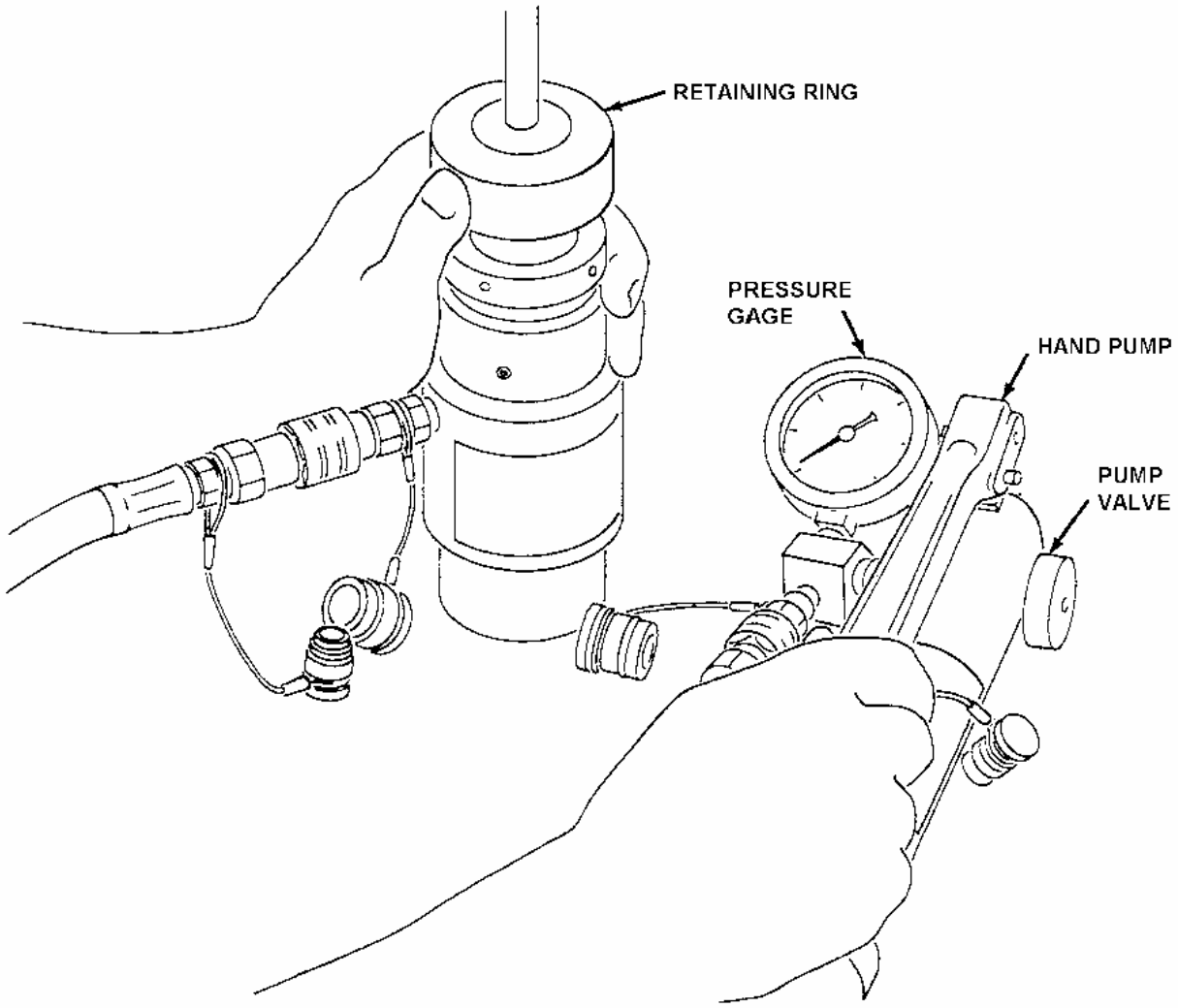
Figure 9. Installing Drawbolt Assembly



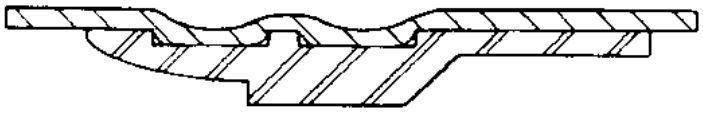
015011

Figure 11. Positioning Retaining Ring



015012

Figure 12. Positioning Retaining Ring

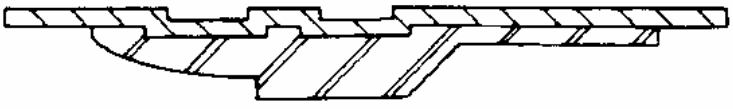


A

CORRECT SWAGE PRESSURE IS INDICATED BY CLEARLY DEFINED RIPPLES IN TUBING WITH INCREASING DEPTH FROM TUBE END INWARD.

B

INADEQUATE SWAGE PRESSURE IS INDICATED BY VERY SHALLOW RIPPLES AND UNCLEAR GROOVE PATTERN.

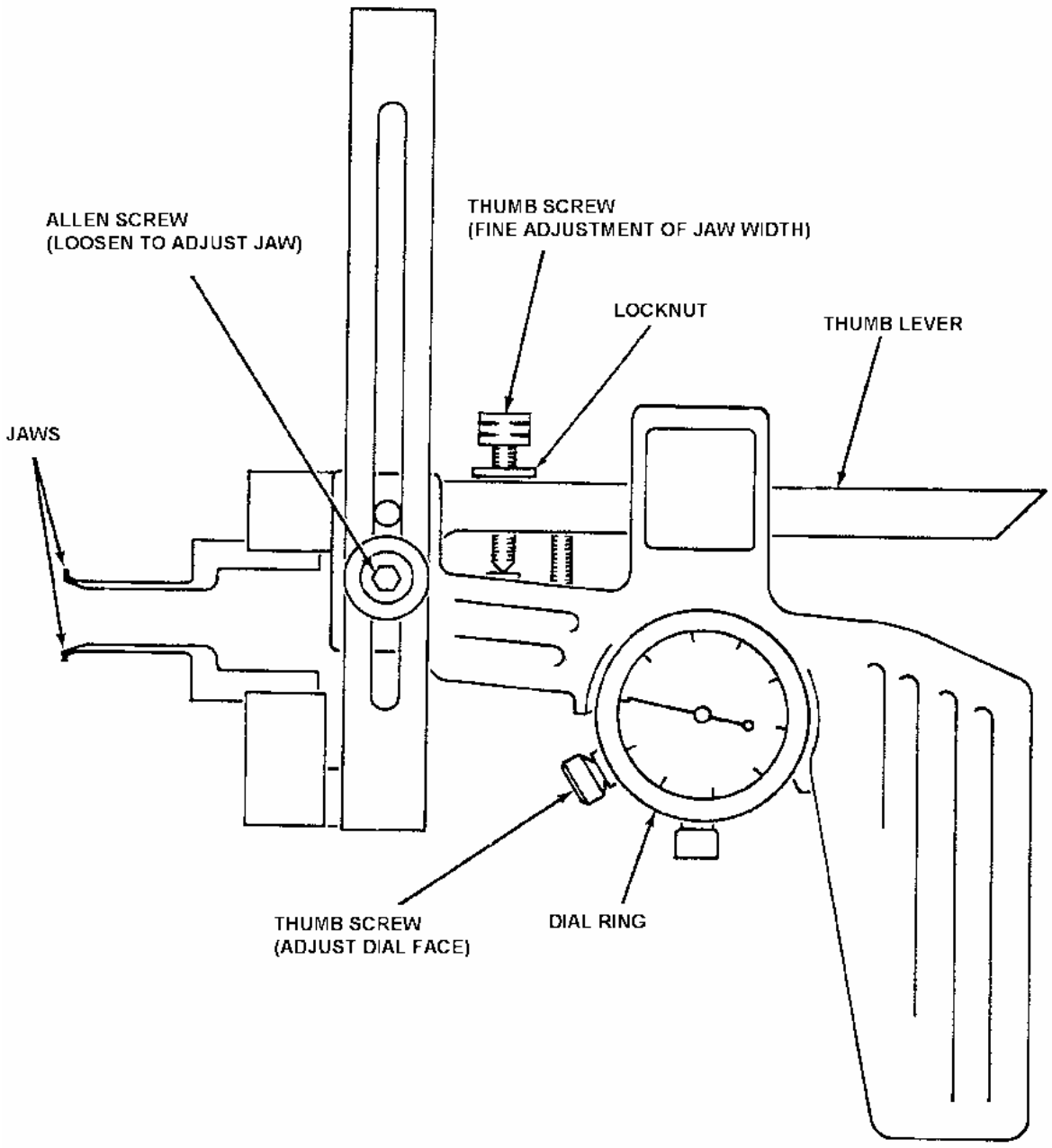


C

EXCESSIVE SWAGE PRESSURE IS INDICATED BY SHARP RIPPLE RADII IN TUBING WHICH FORCES TUBING TO FOLLOW THE GROOVE CONTOUR IN A PATTERN AS SHARP AS THE SLEEVE ITSELF.

015013

Figure 13. Typical Swaged Grooves



015014

Figure 14. Mueller Gage

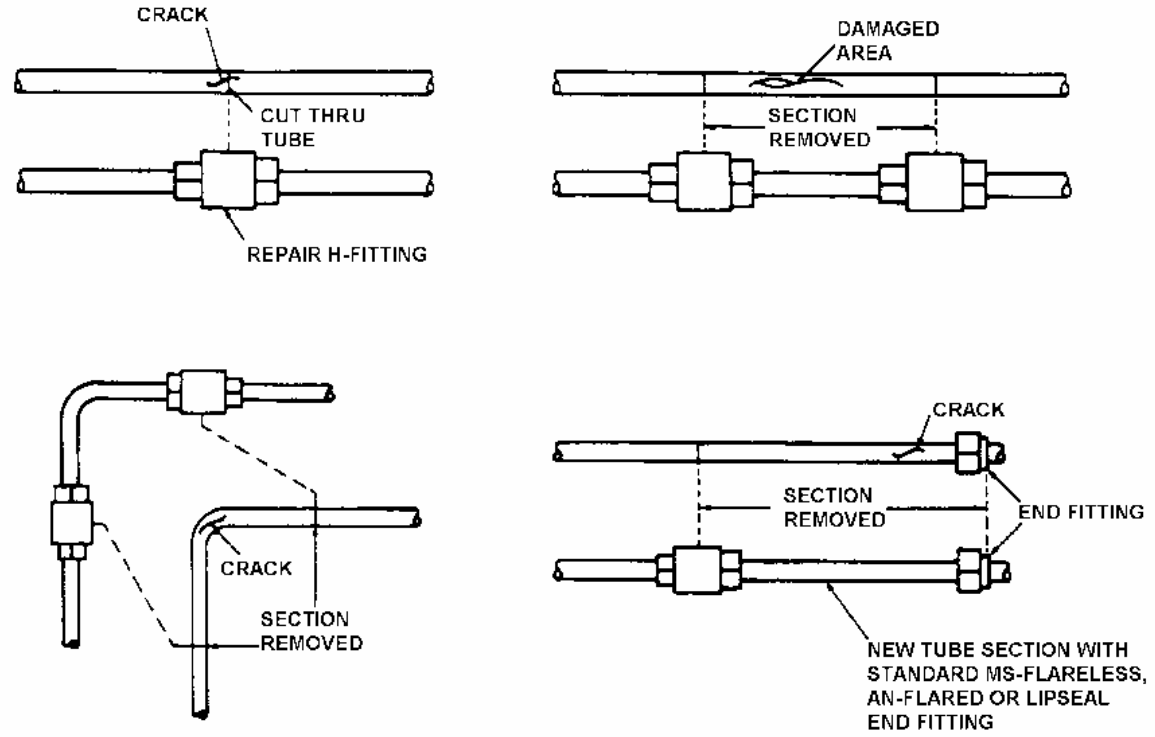


Figure 15. Typical H-Fitting Repair

CAUTION

Too much pressure applied to the cutting wheel at one time may deform the tubing or cause excessive burrs.

b. Apply light pressure on tube by tightening adjusting knob.

c. Rotate cutter toward its open side (Figure 16).

d. As cutter is rotated, adjust tightening knob after each complete turn to maintain light pressure on cutting wheel.

23. Tube Deburring. After tubing is cut, remove all burrs and sharp edges from inside and outside of tube (Figure 18) with deburring tools. Clean out tubing, making sure that no foreign particles remain.

NOTE

A Permaswage deburring tool may be used to remove burrs from inside of tubing (refer to WP011 00).

24. Tube Preparation. After tube is deburred and cleaned, prepare tube as follows:

NOTE

Each fitting is supplied in a plastic bag, together with a positioning template and tape.

a. Select H-fittings from Table 9.

b. Use template to establish tape position and location of tube insertion mark (Figure 17).

c. Wrap one layer of tape on tube end established as tape position (Figure 17). Cut off excess tape.

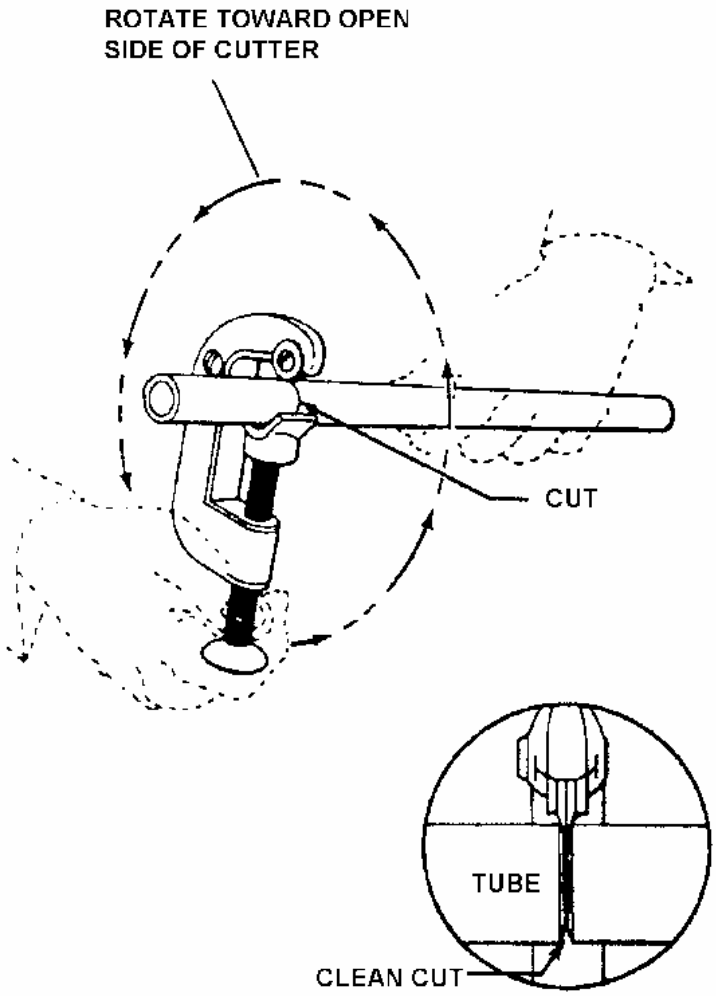
d. Mark tube insert mark as established by positioning template (Figure 17).

25. H-Fitting Installation. Using two standard wrenches, install H-fitting by following the steps in Figure 19. Figure 20 shows H-fitting before and after installation.

Table 8. Tube Material and Maximum Pressure Limitations (psi)

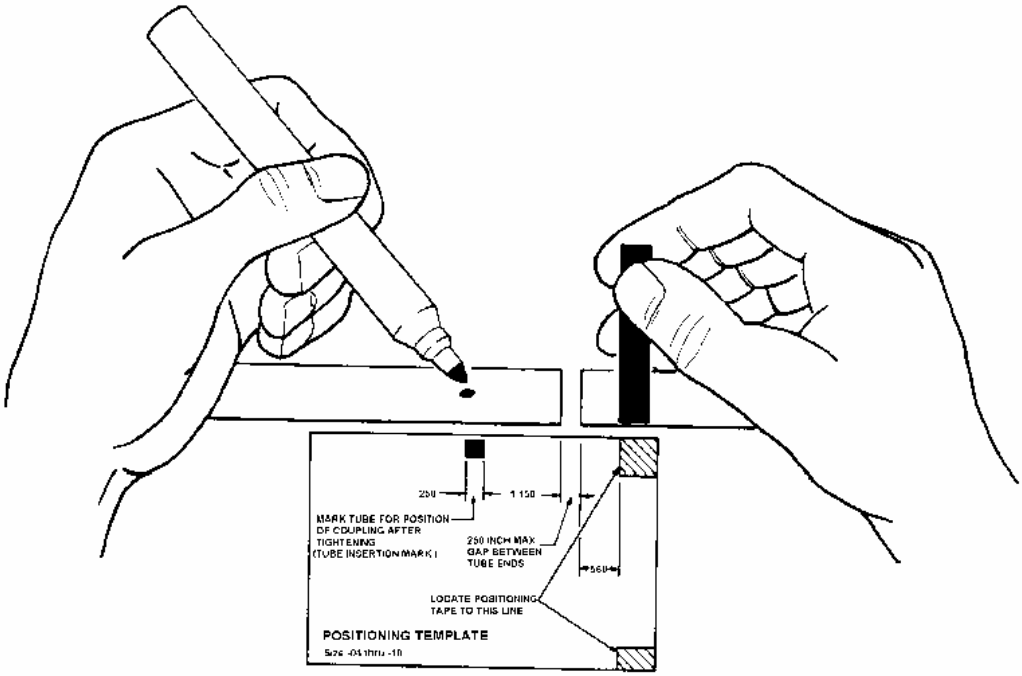
Tubing Material (Note 1)	Line PSI Rating	Minimum Tube Wall Thickness (Note 2)							
		3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
CRES 21-6-9	3000	—	.016	.016	.020	.026	.033	.039	.052
	1500	—	.016	.016	.016	.016	.016	.016	.020
	500	—	—	—	—	—	—	—	—
	250	—	—	—	—	—	—	—	—
AM350	3000	—	.016	—	.018	.020	.022	.026	.035
304 1/8H	3000	.020	.020	.020	.022	.028	.035	.042	.058
	1500	—	—	—	.020	—	—	—	—
	1000	—	—	—	—	—	—	.020	.020
	500	—	—	—	—	—	—	—	—
	250	—	—	—	—	—	—	—	—
304L 1/8H	3000	.020	.020	—	—	—	—	—	—
	1500	.020	.020	—	—	—	—	—	—
321 1/8H	3000	.020	.020	—	.035	.042	.049	.065	.083
	1500	—	.016	—	.016	.020	.025	.035	.058
Titanium 3AL-2.5V Cold WSR	3000	.016	.016	—	.019	.026	.032	.039	.051
	1500	—	—	—	.019	.026	.032	.039	.026
	500	—	—	—	—	—	—	—	—
3AL-2.5V Annealed	3000	—	—	—	.028	.036	.044	.054	.073
	1500	—	—	—	.028	.036	.044	.054	.073
Aluminum Alloy 6061-T6	3000	.028	.035	.042	.049	.065	.065	.095	—
	1500	—	.028	—	.028	.035	.042	.049	.065
	1000	.028	.020	.028	.028	.028	.028	.035	.049
	250	.020	.020	.020	.020	.020	.025	.020	.028

Notes: 1. High-pressure tubing may be substituted for low-pressure tubing when the preferred tubing is unavailable.
2. All dimensions are in inches.



015016

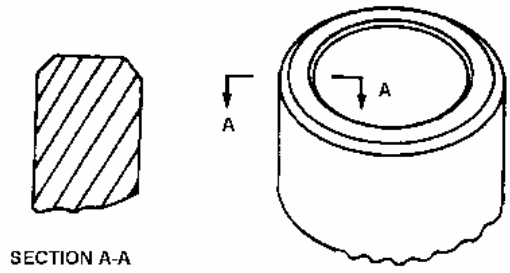
Figure 16. Tube Cutting



NOTE:
1. ALL DIMENSIONS ARE IN INCHES.

015017

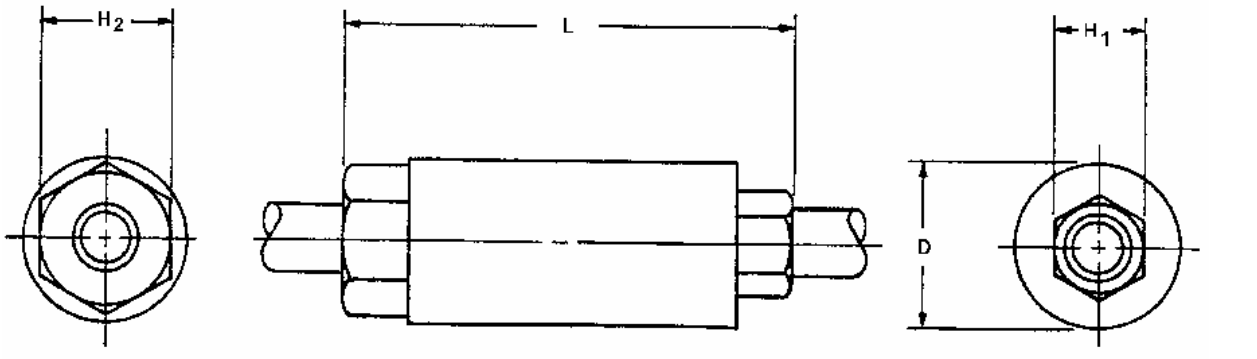
Figure 17. Tube Preparation



015018

Figure 18. Properly Deburred Tubing

Table 9. H-Fitting Dimensions



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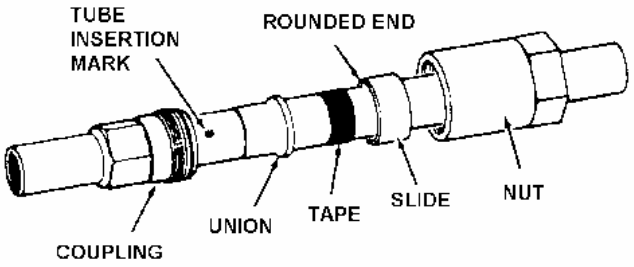
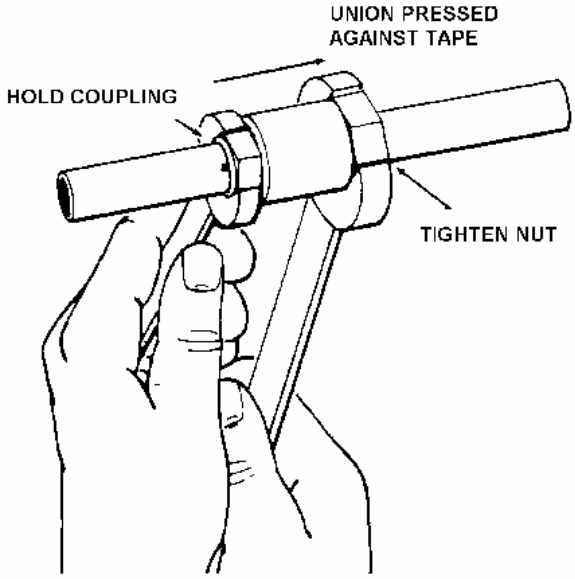
Sierracin/Harrison Part No.	Tube OD (Note 1)	D Dia. (Note 1)	H_1 (Note 1)	H_2 (Note 1)	L (Note 1)	
					Before Swage	After Swage
36011V04	1/4 .250	.780	7/16 .438	11/16 .688	3.03	2.35
36011V05	5/16 .3125	.900	1/2 .500	3/4 .750	3.21	2.35
36011V06	3/8 .375	.950	5/8 .625	3/4 .750	3.14	2.35
36011V08	1/2 .500	1.125	3/4 .750	7/8 .875	3.25	2.35
36011V10	5/8 .625	1.300	7/8 .875	1 1/16 1.063	3.26	2.35
36011V12	3/4 .750	1.420	15/16 .938	1 1/4 1.250	3.43	2.95
36011V16	11.000	1.700	1 3/16 1.187	1 1/2 1.500	3.46	2.95

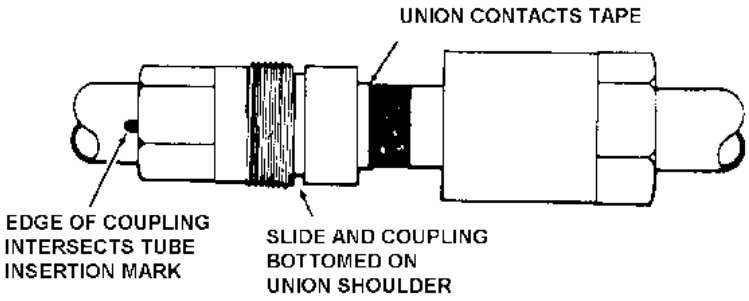
Notes: 1. All dimensions are in inches.



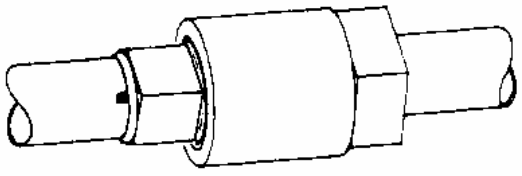
STEP 1. POSITION FITTING COMPONENTS ONTO TUBE ENDS WITH UNION AGAINST TAPE.



STEP 2. START NUT ONTO COUPLING AND TIGHTEN WITH UNION AGAINST TAPE. HOLD COUPLING END - DO NOT TURN. CONTINUE TIGHTENING NUT UNTIL TORQUE INCREASE IS FELT AS THE SLIDE AND COUPLING BOTTOM AGAINST UNION. CHECK FOR VISIBILITY OF TUBE INSERTION MARK.



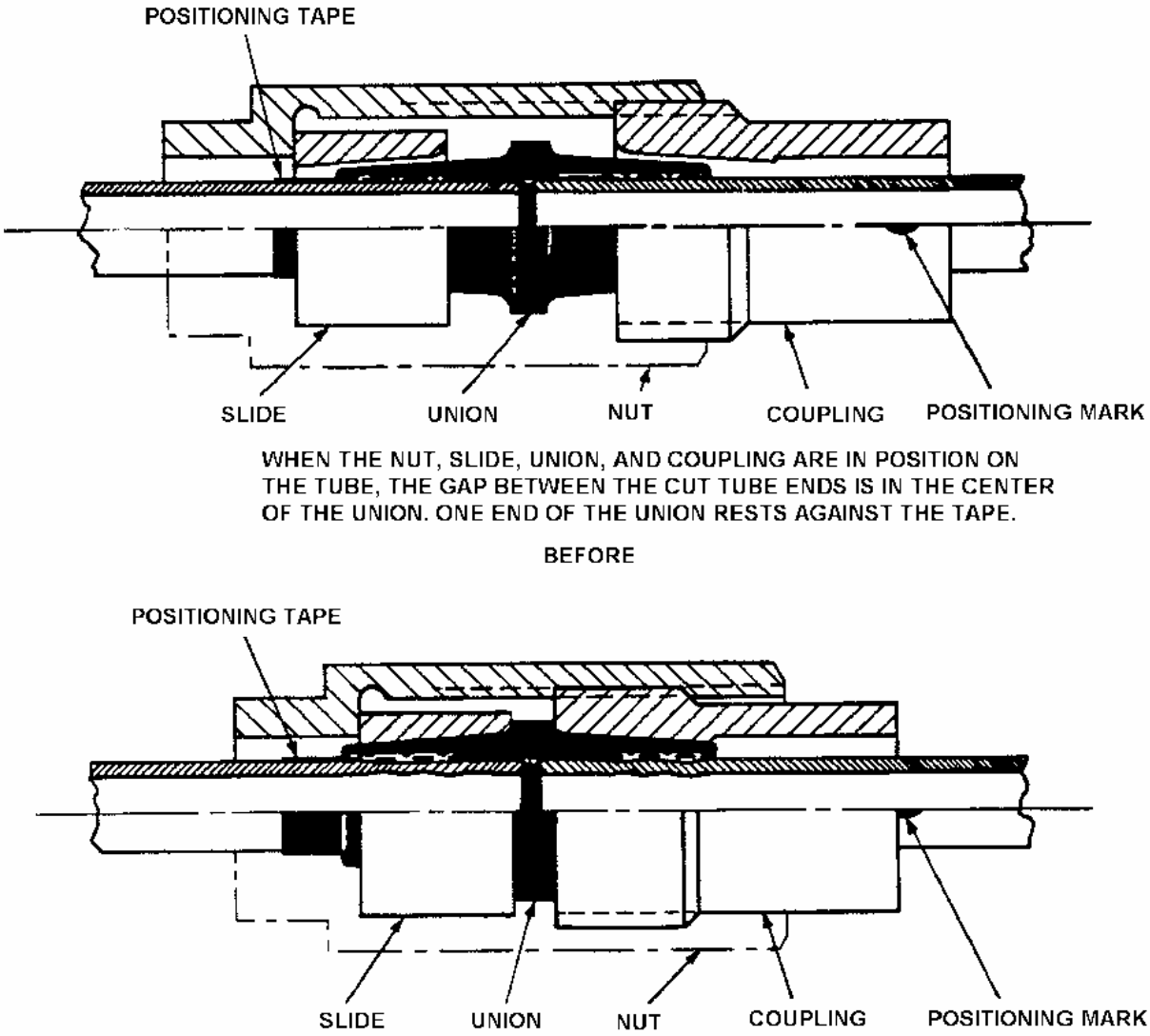
STEP 3. BACK OFF NUT AND ASSURE THAT SLIDE AND COUPLING ARE BOTTOMED AGAINST SHOULDER OF UNION. UNION MUST CONTACT TAPE AND EDGE OF COUPLING MUST INTER-SECT TUBE MARK.



STEP 4. RETIGHTEN ASSEMBLY. SWAGE IS COMPLETE.

015019

Figure 19. H-Fitting Installation



015020

Figure 20. H-Fitting Before and After Installation

ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION AND MAINTENANCE

CRYOFIT FITTINGS

Reference Material

None

Alphabetical Index

Subject	Page No.
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Cryofit Couplings Delivery	2
Cryofit Couplings Usages	2
Emergency Procedures	2
Installation	2
Installation Procedures	8
Preparation for Installation	4
Special Installation Tools	2

Record of Applicable Technical Directives

None

1. GENERAL.

2. The Cryofit coupling is a permanent tube and pipe joining product, using the shape-memory properties of a unique alloy of Titanium and Nickel (TiNi). This cryogenically cooled coupling actually shrinks as it warms to room temperature, making a leakproof compression joint in high-reliability, high-pressure piping systems. Only depot level is authorized to use the Cryofit procedures.

3. CRYOFIT COUPLINGS USAGES. Cryofit couplings are use to permanently install or repair straight sections of hydraulic or pneumatic tubing. By combining the couplings with Cryofit compatible fittings, tee and elbow connections can be made. Figure 1 illustrates these installations. Cryofit couplings are qualified for use in hydraulic systems with operating pressures up to 3000 psi. Table 1 indicates the tube materials which may be joined with Cryofit couplings.

4. CRYOFIT COUPLINGS DELIVERY. Raychem Corporation ships its Cryofit couplings in liquid nitrogen at a temperature of -320° F until just before installation. As received, they have an Inside Diameter (ID) which is larger than the Outside Diameter (OD) of the tubes they will connect. If the Cryofit coupling is removed from the liquid nitrogen and warmed to room temperature, it will shrink to an ID which is smaller than the OD of the tube. If tie coupling is slipped over two tube ends before it warms, it will shrink and compress the tubes to form a permanent connection.

5. EMERGENCY PROCEDURES. In case of a liquid nitrogen spill, proceed as follows:

a. Stay clear of the spilled liquid nitrogen. It should be allowed to evaporate under adequate ventilation.

b. Immediately remove any clothing or shoes which have come in contact with liquid nitrogen and flush skin with cold water.

c. If any prolonged contact with part of the body occurs, immediately flush with cold water and obtain medical attention. In case of eye contact with liquid nitrogen, flush immediately with water and get medical attention.

6. INSTALLATION.

Materials Required

Specification or Part Number	Nomenclature
A-A-59503	Nitrogen

7. Only personnel who have completed documented training on installation of cryofit fittings by instructors certified by Cryofit manufacturer, Advanced Metal Components Inc., or by Advanced Metal Components Inc. surrogates, are authorized to install cryofit fittings. Observe the following precautions and use personal protective equipment (Table 2) when installing Cryofit fittings.

WARNING

Wear goggles or faceshield, gloves, and apron or coverall when working with liquid nitrogen (LN_2). Liquid nitrogen at -320°F can cause serious frostbites.

Do not contact areas of tools, couplings, or materials which have been cooled by liquid nitrogen without wearing protective gear.

Work areas shall have adequate ventilation as approved by the local safety officer. Liquid nitrogen will displace oxygen in confined areas and can cause suffocation.

When transferring liquid nitrogen in bulk, pour only a small amount slowly to avoid splashing, thermal shock, and rapid pressure buildup.

8. SPECIAL INSTALLATION TOOLS. Cryofit couplings are installed using special hand tools. Table 3 gives the part numbers for the tools required to install each size Cryofit coupling. All tools are available individually. The function of each tool is described below.

a. Installation tool (Table 4) picks up and holds the coupling during installation or transfer.

b. Test coupling (Table 5) ensures proper tube alignment and locates installation marks on the tube.

c. Tube chiller (Table 6) cools the tube prior to installing the coupling.

d. Check gage (Table 7) ensures proper coupling location.

e. Work box (Figure 2) transports couplings from the storage area to the work stations.

f. Masking tape is used as a positioning stop to aid in properly locating the coupling.

g. Marking pen is used to mark the tube prior to installation. Any waterproof, narrow, felt-tip pen is acceptable.

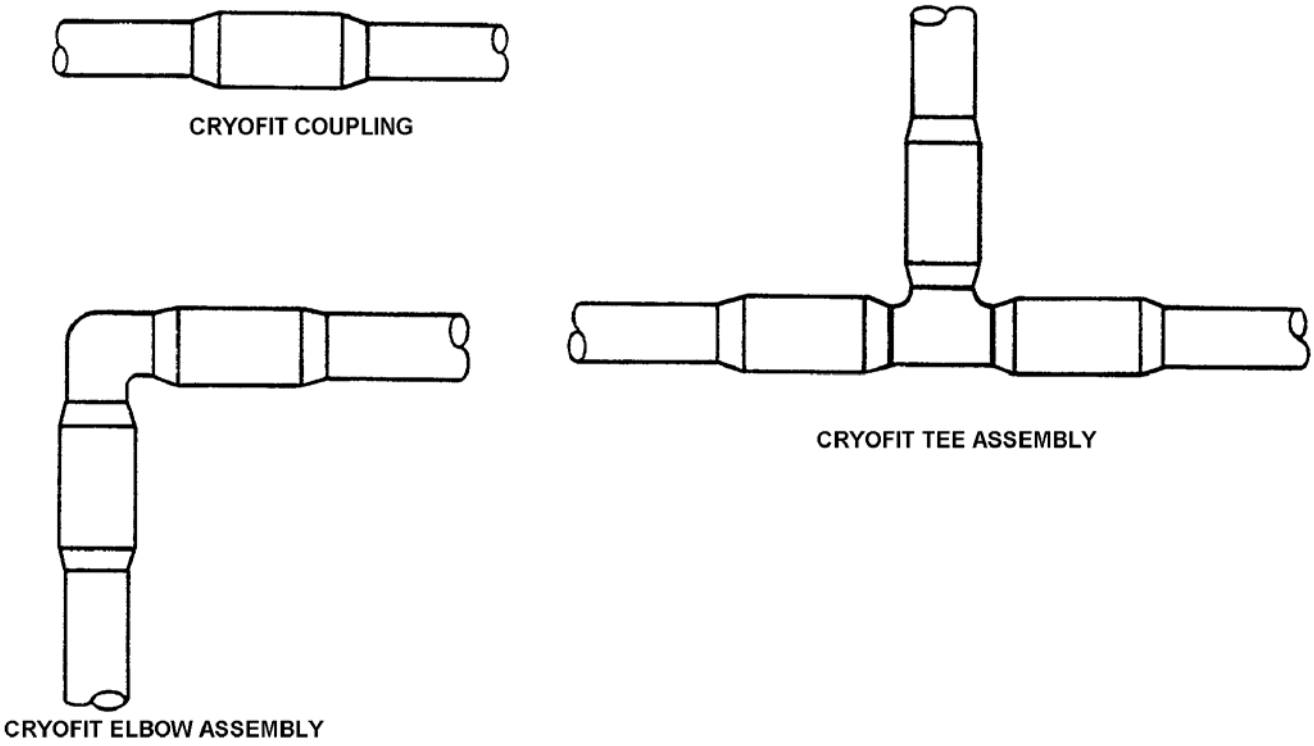

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Figure 1. Cryofit Fittings Installation

Table 1. Acceptable Tube Materials and Wall Thickness for Cryofit Coupling Connections

Cryofit Couplings	Wall Thickness			
	21-6-9 (Note 1)	304 1/8 H (Note 1)	321 1/8 H (Note 1)	3AL-2.5V CWSR (Note 1)
3P02111-4L	.016	.020	.020	.016
3P02111-6L	.020	.028	.028	.019
3P02111-8L	.026	.035	.035	.026
3P02111-10L	.033	.042	.042	.032
3P02111-12L	.039	.049, .058	.049	.039
3P02111-16L	.052	.058, .065	.058	.051
Notes: 1. All dimensions are in inches.				

Table 2. Personal Protective Equipment Required When Working with Liquid Nitrogen

Nomenclature	Specification/ Part Number
Apron, Rubber	ZZ-A-605
Faceshield, Industrial	LF-36
Gloves, Rubber, Industrial Synthetic	MIL-G-12223
Goggles, Industrial Rubber Frame	GG-G-521

9. PREPARATION FOR INSTALLATION. Before installing a Cryofit coupling, ensure the coupling maintains its ID and the tubes are properly prepared.

10. Coupling Storage. Special insulated liquid nitrogen containers, called dewars, (Figure 3) are used for storing Cryofit couplings. Couplings are stored in trays or drawers within the dewar.

Nitrogen, A-A-59503 **8**

NOTE

To avoid coupling shrinkage while in storage, the liquid nitrogen level in the storage container must be maintained at a level above the couplings. Any tool which will come in contact with the couplings should be precooled in liquid nitrogen.

If a coupling shrinks before being installed on a tube, it should be returned to Raychem Corporation for re-expansion.

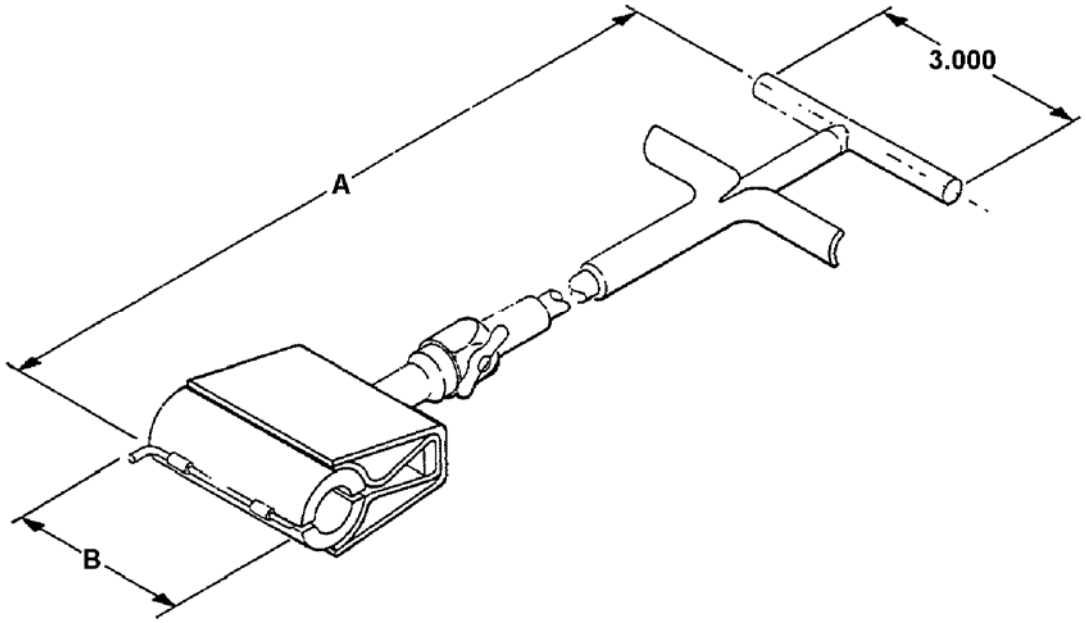
11. Inspection of Coupling ID. If there is reason to believe that a coupling has been warmed (such as a low liquid nitrogen level in the dewar or that it has been previously removed from liquid nitrogen), its ID can be checked as follows:

Table 3. Installation Tool Part Numbers

Coupling Part No. (Note 1)	Tube Size (Note 3)	Installation Tool	Test Coupling	Check Gage	Tube Chiller	Tool Set (Note 2)
3P02111-4L	1/4	UT3P02111-4	TC3P02111-4	CG3P02111-4	910415-01	TS3P02111-4
3P02111-6L	3/8	UT3P02111-6	TC3P02111-6	CG3P02111-6	910415-01	TS3P02111-6
3P02111-8L	1/2	UT3P02111-8	TC3P02111-8	CG3P02111-8	910415-01	TS3P02111-8
3P02111-10L	5/8	UT3P02111-10	TC3P02111-10	CG3P02111-10	910415-02	TS3P02111-10
3P02111-12L	3/4	UT3P02111-12	TC3P02111-12	CG3P02111-12	910415-02	TS3P02111-12
3P02111-16L	1	UT3P02111-16	TC3P02111-16	CG3P02111-16	910415-02	TS3P02111-16

Notes: 1. Work Box Part No. WB910825 (Refer to Paragraph 8, step e.)
2. Tool Set Includes: 1 Installation Tool
1 Test Coupling
1 Check Gage
1 Tube Chiller
1 Storage Box
3. All dimensions are in inches.

Table 4. Installation Tool

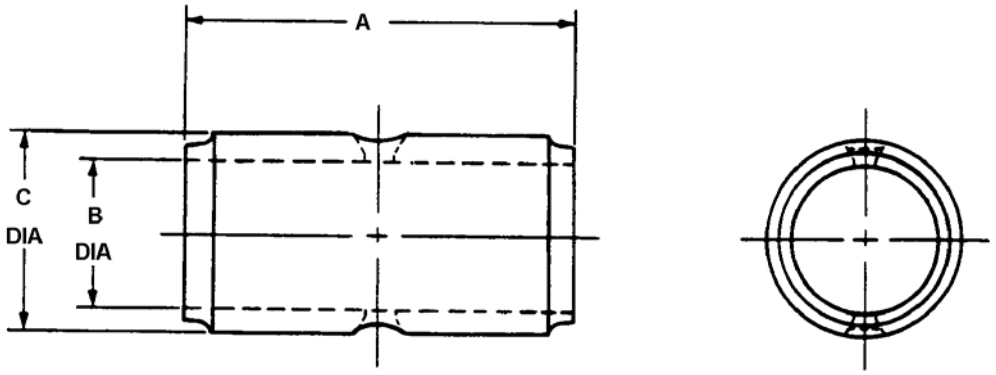


016t04a

Part No.	Size	A	B
UT3P02111-4	1/4	11.0	1.12
UT3P02111-6	3/8	11.0	1.38
UT3P02111-8	1/2	11.3	1.50
UT3P02111-10	5/8	11.5	1.79
UT3P02111-12	3/4	11.8	2.07
UT3P02111-16	1	12.0	2.70

Notes: 1. All dimensions are in inches.

Table 5. Test Coupling



016t05a

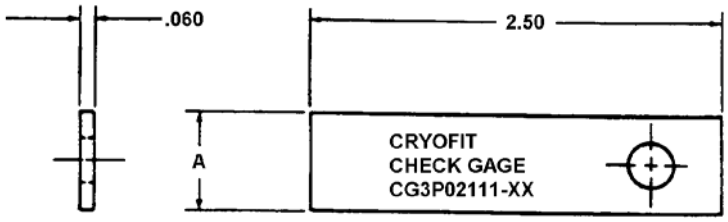
Part No.	Tube Size	A	B Dia.	C Dia.
TC3P02111-4	1/4	1.086	.254	.366
TC3P02111-6	3/8	1.343	.382	.525
TC3P02111-8	1/2	1.460	.510	.687
TC3P02111-10	5/8	1.747	.635	.839
TC3P02111-12	3/4	2.014	.762	1.014
TC3P02111-16	1	2.631	1.012	1.370
Notes: 1. All dimensions are in inches.				

Table 6. Tube Chiller

016t06a

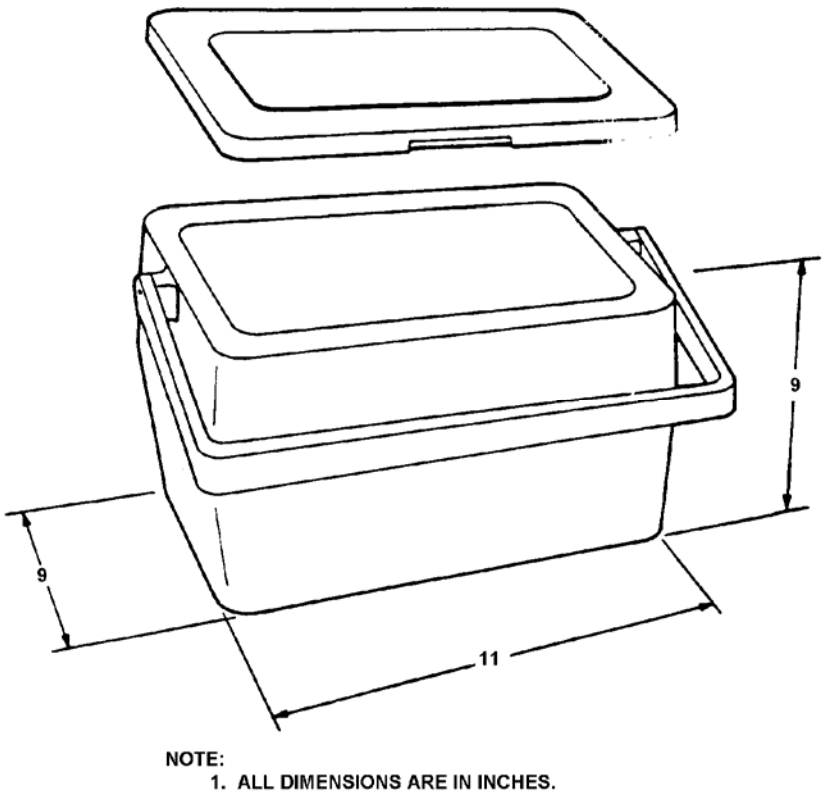
Part No.	Size	A	B
910415-01	-3 through -8	2.50	4.00
910415-02	-10 through -16	3.50	4.50
Notes: 1. All dimensions are in inches.			

Table 7. Check Gage



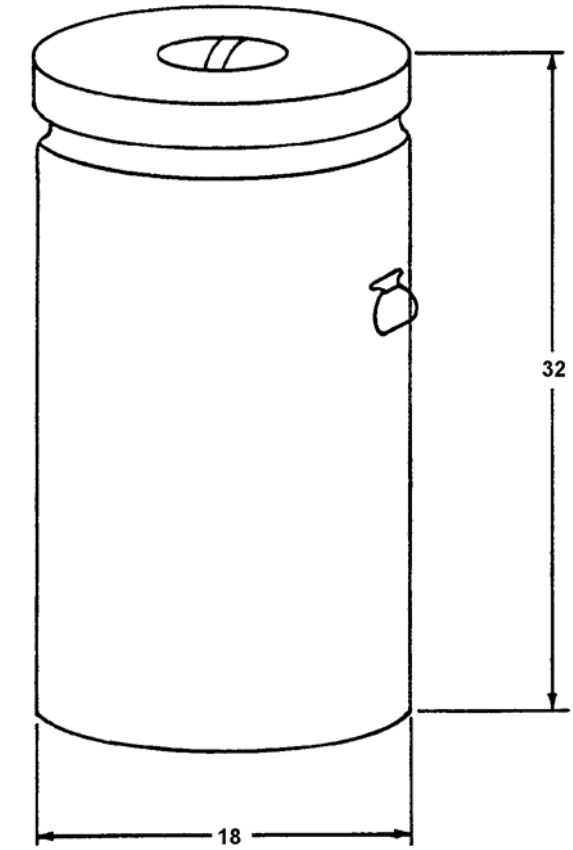
016t07a

Part No.	Fitting Size	A
CG3P02111-4	1/4	.595
CG3P02111-6	3/8	.720
CG3P02111-8	1/2	.778
CG3P02111-10	5/8	.918
CG3P02111-12	3/4	1.049
CG3P02111-16	1	1.351
Notes: 1. All dimensions are in inches.		



016002

Figure 2. Work Box



NOTE:
1. ALL DIMENSIONS ARE IN INCHES.

016003

Figure 3. Dewar

a. Obtain a length of the same size tubing as the coupling, approximately 6 inches long.

Nitrogen, A-A-59503 **8**

b. Cool the tube in liquid nitrogen until boiling stops.

c. Being careful to keep the coupling in the liquid nitrogen, use an installation tool to insert the tube into the coupling. The tube should slip easily through the entire bore of the coupling.

d. If the tube cannot pass through the coupling, the coupling should be removed from stock and returned to Raychem for re-expansion.

12. Tube Preparation. The following steps will ensure that the tube is properly prepared for the coupling installation. This procedure describes the replacement of existing tube sections as well as new installations on the aircraft.

a. Mark the tube at the point where cuts must be made to remove the damaged section. Generally, a length of straight tube equal to the coupling length must remain after the damaged section is removed.

b. Cut the tube at the marks, using a roller-type cutter to avoid generating chips which could contaminate the system. Deburr the tube ends.

c. Cut and deburr a splice tube to replace the damaged section which has been removed. The splice should butt against the remaining tube ends, if possible. A maximum gap of .120 inch between tube ends is permissible.

d. Inspect all tube ends to be sure they are free of burrs and meet dimensional specifications.

13. INSTALLATION PROCEDURES. The procedures for installing couplings, elbows and tees are similar. With the elbows and tees, some steps are repeated.

14. Coupling Installation. Observe precautions of Paragraph 7 and proceed as follows:

a. Obtain the proper Cryofit couplings and installation tools (Tables 3 and 8).

b. Prepare tubes in accordance with paragraph 12 above.

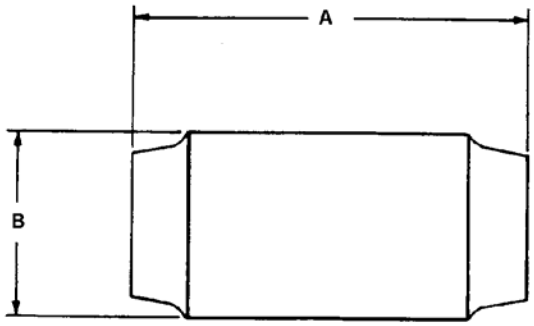
c. Clean and dry any hydraulic fluid from the tube ends which might interfere with marking the tubes.

d. To ensure that the tubes are round and free of burrs which could interfere with coupling installation, slip a test coupling (Table 5) over the tube ends. The test coupling should slide freely.

e. Position the test coupling so that both tubes are visible in the test coupling window. The tubes should be butted together, if possible. However, if both tubes are visible, the gap less than .120 inch is acceptable.

f. Using the marking pen, draw a line at each end of the test coupling. These are the insertion marks (Figure 4).

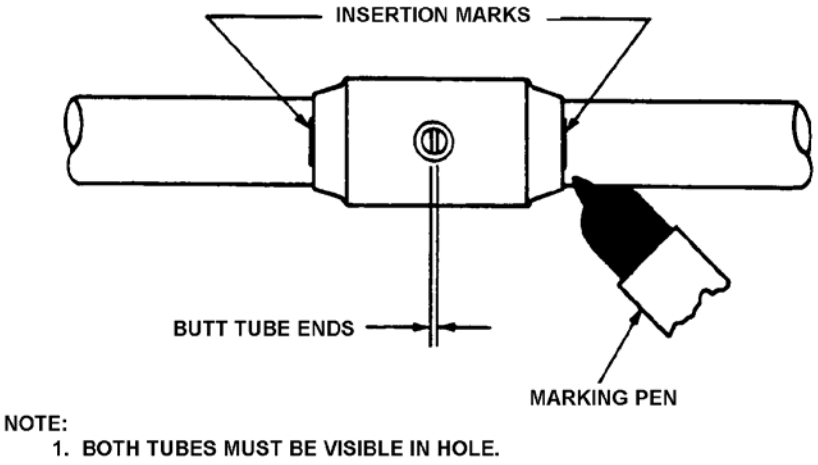
Table 8. Cryofit Couplings



016t08a

Tube Size	Part No.	A Length (Note 1)	B Diameter (Note 1)
-4	3P02111-4L	1.108	.349
-6	3P02111-6L	1.371	.499
-8	3P02111-8L	1.490	.651
-10	3P02111-10L	1.782	.794
-12	3P02111-12L	2.055	.959
-16	3P02111-16L	2.685	1.295

Notes: 1. All dimensions are in inches.



016004

Figure 4. Locating Insertion Marks on Coupling

g. Reposition the test coupling so it is flush with the tube end. Draw a second line at the opposite end of the test coupling. This is the check gage mark (Figure 5). Repeat on the second tube.

h. To aid in positioning the coupling, apply two wraps of tape at the insertion mark on one tube (Figure 6). Check the tape location by positioning the test coupling so that it is butted against the tape. Both tube ends must be visible in the window.

NOTE

A small clamp may be used in place of the tape.

i. Using the test coupling and installation tool, practice the installation to determine the fastest and easiest method.

Nitrogen, A-A-59503 **8**

NOTE

Any tool which will come in contact with a Cryofit coupling must be prechilled in liquid nitrogen to avoid warming and shrinking the coupling.

j. Cool the end of the installation tool and tube chiller in liquid nitrogen (Figure 7) until boiling stops.

k. Apply the cold tube chiller to the tube joint (Figure 8) until the tube is chilled (about 1 minute for 1/4-inch tube and 3 minutes for 1-inch tube).

NOTE

The tube chiller will cool the tube ends and provide additional time before the coupling warms and shrinks into position.

l. Keeping the coupling in the liquid nitrogen, verify the coupling size and grasp it with the chilled installation tool.

m. Remove the tube chiller from the tube.

n. Deflect one tube to allow the coupling to be slipped over the end.

o. Using the installation tool, slip the coupling onto the tube without the tape (Figure 9). Realign the tubes and slide the coupling against the tape.

p. Check to ensure that the coupling is properly positioned against the tape and that the other tube has been inserted to the installation mark.

q. Remove the installation tool and the coupling to warm and shrink into the tube.

NOTE

After shrinkage, the coupling installation should be inspected to confirm that the tubes have been inserted into the coupling to the proper depth.

r. Place the check gage against the coupling end. The check gage should reach or cover the inspection mark (Figure 10).

s. Repeat on the other end of the coupling. If the check gage reached both inspection marks, the tubes have been properly inserted and the connection is complete (Figure 10).

NOTE

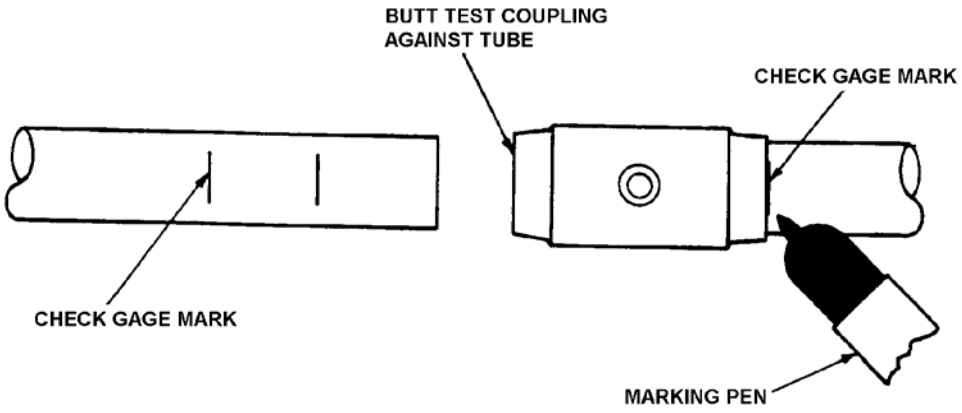
If the check gage does not reach the inspection mark, the coupling has not been properly installed and must be replaced.

15. Tee and Elbow Installation. Tee and elbow fittings are installed by connecting each leg of the fitting to the corresponding tube with a separate Cryofit coupling. Observe precautions of Paragraph 7 and proceed as follows:

a. Obtain the proper Cryofit couplings, fittings, and installation tools (Tables 3 and 8 through 10).

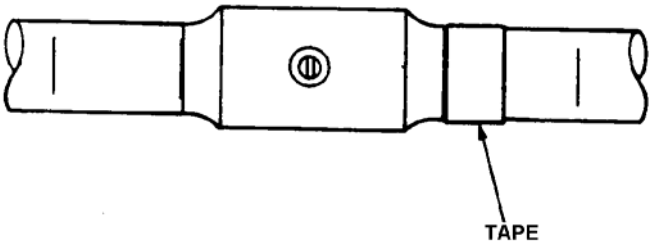
b. Prepare tube ends in accordance with paragraph 12 above.

c. Clean and dry any hydraulic fluid from the tube ends which might interfere with marking the tubes.



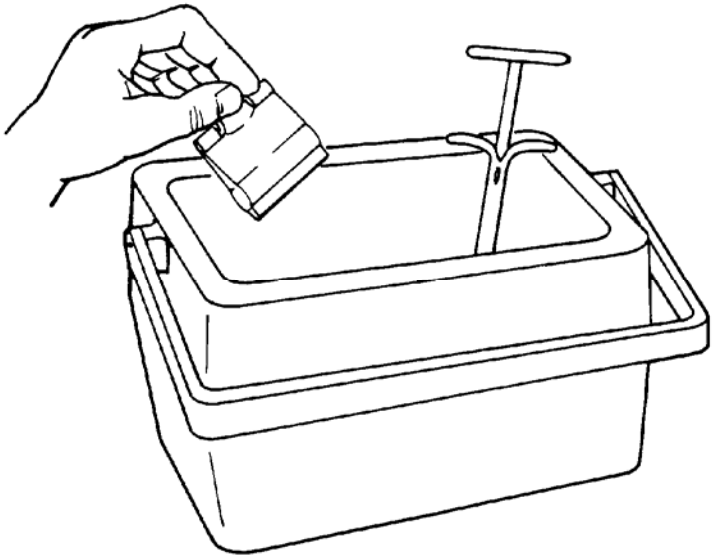
016005

Figure 5. Locating Check Gage Marks on Coupling



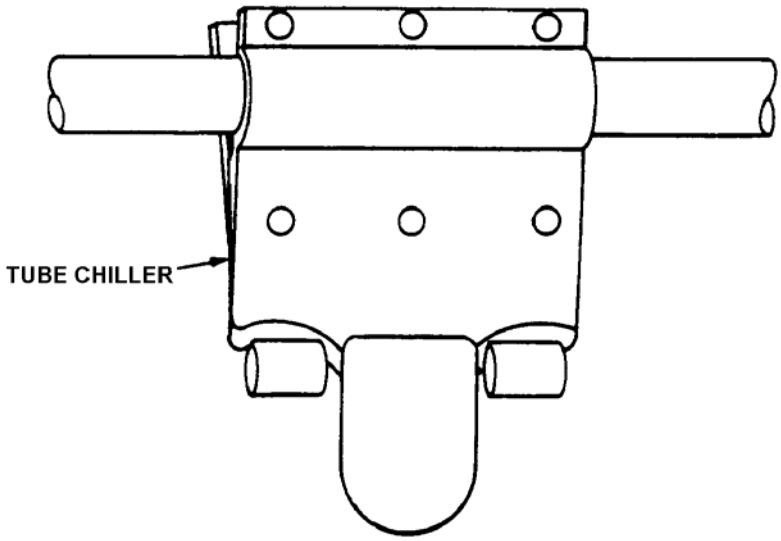
016006

Figure 6. Taping the Insertion Mark



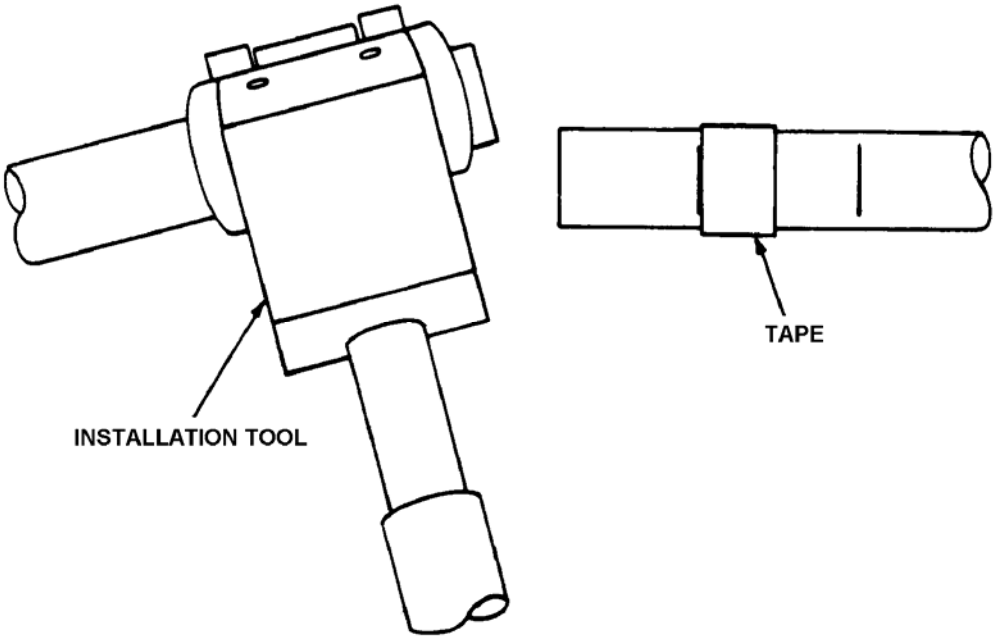
016007

Figure 7. Prechill Tools



016008

Figure 8. Application of Tube Chiller on Tube Joint



016009

Figure 9. Installing Cryofit Coupling

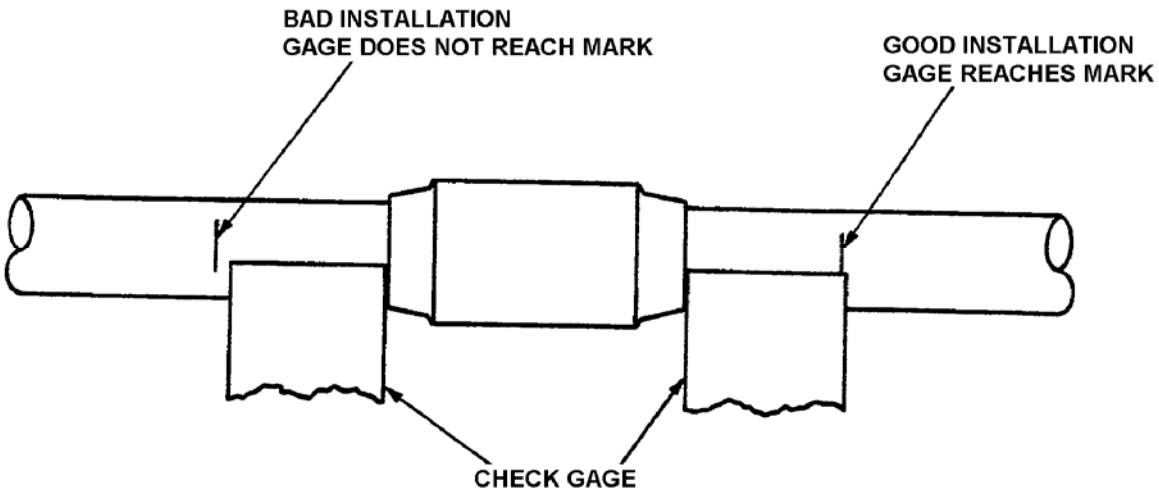


Figure 10. Checking Cryofit Coupling

CAUTION

With the fitting in position, the gap between fitting legs and tube ends must be less than .120 inch.

d. Position the fitting so that all legs are aligned with their respective tubes.

e. Slip a test coupling over each fitting leg/tube joint. The test coupling should slide freely. With the test coupling butted against the fitting shoulder, the tube end must be visible in the coupling window. Adjust tubes, if necessary.

f. With the test coupling positioned against the fitting shoulder, draw a line on the tube at the opposite end of the test coupling. This is the insertion mark (Figure 11).

g. Reposition the test coupling so that it is flush with the tube end. Draw a second line at the opposite end of the coupling for a check gage mark (Figure 12).

h. Steps d through g must be completed for each fitting leg.

i. Recheck tube alignment and gap by placing the test couplings in position against the fitting shoulder. Ensure that all tube ends are visible in the test coupling windows.

j. Using the installation tool and the test coupling from one leg, practice the installation to determine the fastest and easiest method.

Nitrogen, A-A-59503 **8**

NOTE

Any tool which will come in contact with a Cryofit coupling must be prechilled in liquid nitrogen to avoid warming and shrinking the coupling.

k. Cool the end of the installation tool and tube chiller in liquid nitrogen until boiling stops (Figure 7).

l. Remove the test coupling from one fitting leg and apply the tube chiller to the fitting leg and tube until chilled (about 1 minute for 1/4 inch tube and 3 minutes for 1 inch tube). Leave remaining test couplings in position to maintain proper tube/fitting alignment (Figure 13).

Nitrogen, A-A-59503 **8**

m. Keeping the coupling covered with liquid nitrogen, verify its size and grasp it with the chilled installation tool.

n. Remove the tube chiller from the tube.

o. Deflect the tube and, using the installation tool, slip the coupling over the end. Realign the tube and slide the coupling against the fitting shoulder (Figure 14).

p. Check to ensure that the coupling has been properly positioned against the fitting shoulder, and that the tube has been inserted to the installation mark. Also check to ensure that remaining fitting legs are in proper alignment; adjust if necessary.

q. Remove the installation tool and allow the coupling to warm and shrink into position.

NOTE

The installation of each coupling on the fitting must be inspected to ensure that the tube and fitting have been properly inserted.

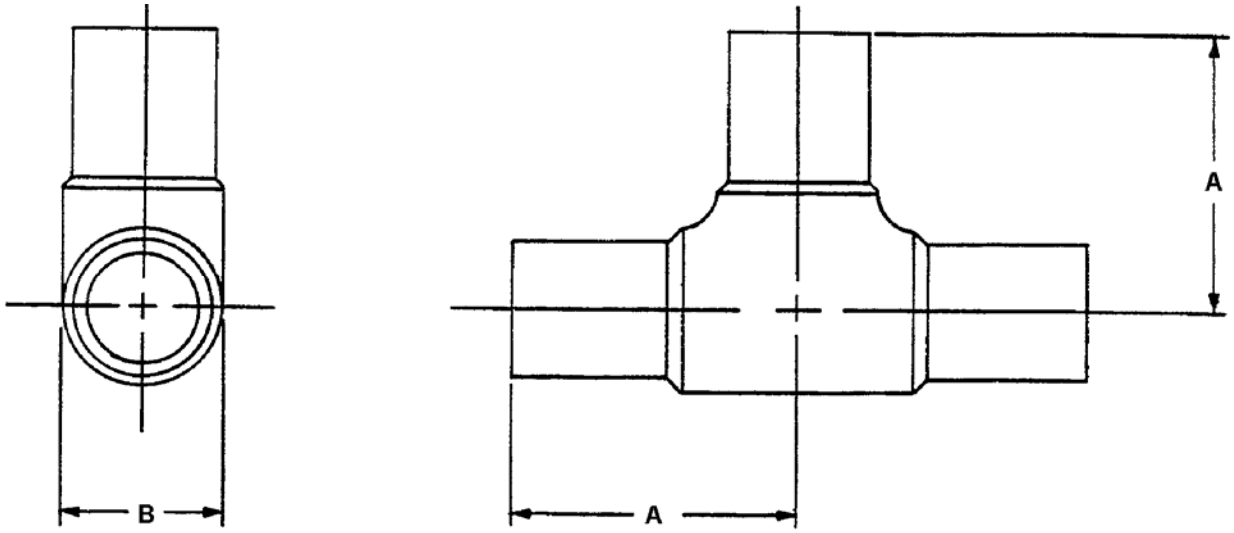
r. Place the check gage against the coupling at the tube end. The check gage should reach or cover the inspection mark. At the fitting end, the edge of the check gage should not slip freely between the coupling end and the fitting shoulder.

NOTE

If the check gage does not reach the inspection mark or slips between the coupling and fitting shoulder, the coupling is not properly installed (Figure 15) and the fitting must be replaced.

s. Repeat steps j through r for each fitting leg.

Table 9. Cryofit Elbows

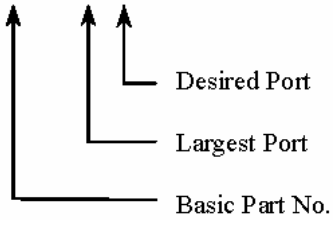


016t09a

Largest Port Size		Elbow Size (Note 2)					
		-4	-6	-8	-10	-12	-16
Dimensions	**Desired Port Size (Note 2)**	**Inches**	**Inches**	**Inches**	**Inches**	**Inches**	**Inches**
A (Note 1)	4	.860	.958	1.086	1.223	1.321	1.487
	6	—	1.044	1.181	1.320	1.416	1.583
	8	—	—	1.196	1.342	1.440	1.616
	10	—	—	—	1.452	1.551	1.717
	12	—	—	—	—	1.650	1.817
	16	—	—	—	—	—	2.060
B		.325	.452	.562	.697	.822	1.072

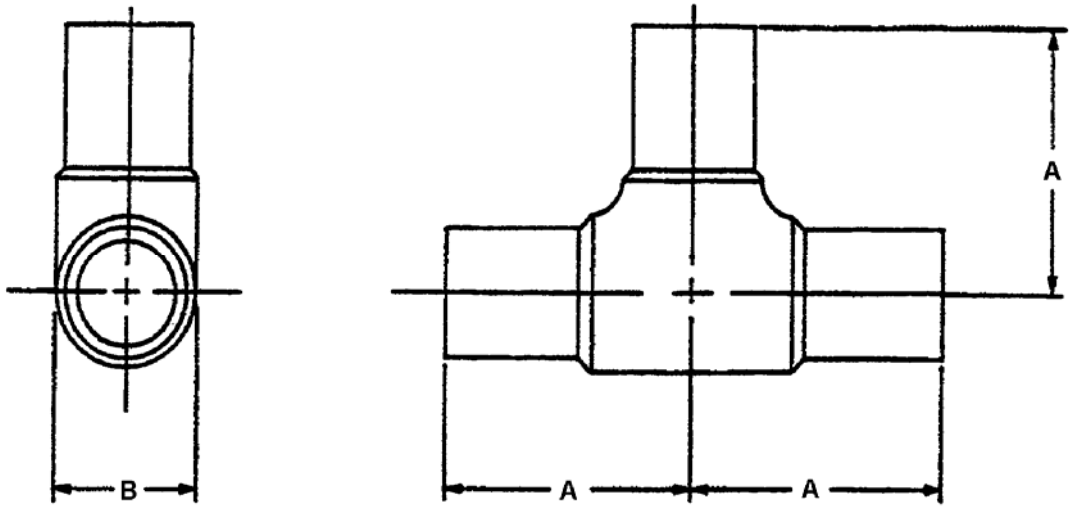
Notes: 1. Dimension A varies with forging size (largest port size). To determine A for a specific elbow, choose the largest port size from the top row and the desired port size at the left column.

2. Example of a Cryofit elbow part no.: 3P02211-08-06.



016t09b

Table 10. Cryofit Tees

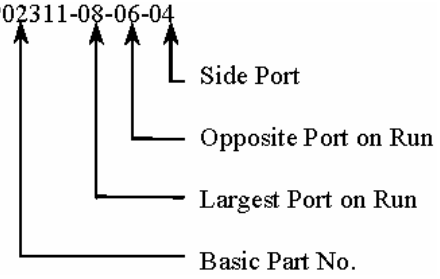


016t10a

Largest Port Size		Tee Size (Note 2)					
		-4	-6	-8	-10	-12	-16
Dimensions	Desired Port Size (Note 2)	Inches	Inches	Inches	Inches	Inches	Inches
A (Note 1)	4	.860	.958	1.086	1.223	1.321	1.487
	6	—	1.044	1.181	1.320	1.416	1.583
	8	—	—	1.196	1.342	1.440	1.616
	10	—	—	—	1.452	1.551	1.717
	12	—	—	—	—	1.650	1.817
	16	—	—	—	—	—	2.060
B		.325	.452	.562	.697	.822	1.072

Notes: 1. Dimension A varies with forging size (largest port size). To determine A for a specific tee, choose the largest port size from the top row and the desired port size at the left column.

2. Example of a Cryofit tee part no.: 3P02311-08-06-04



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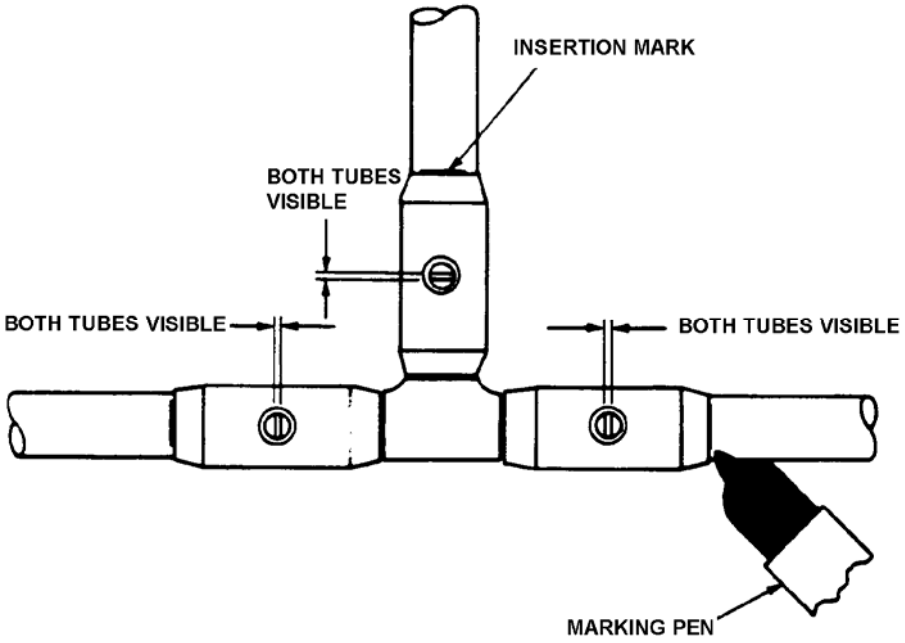
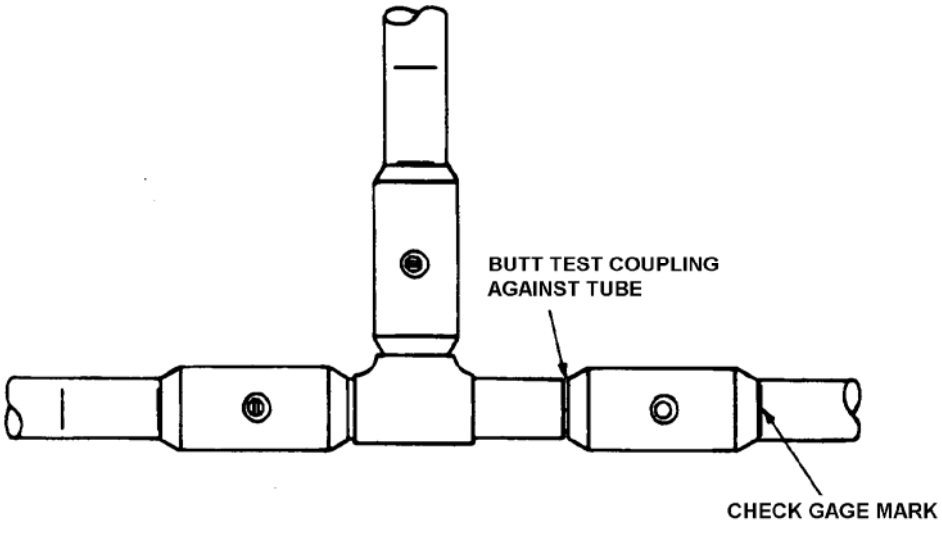


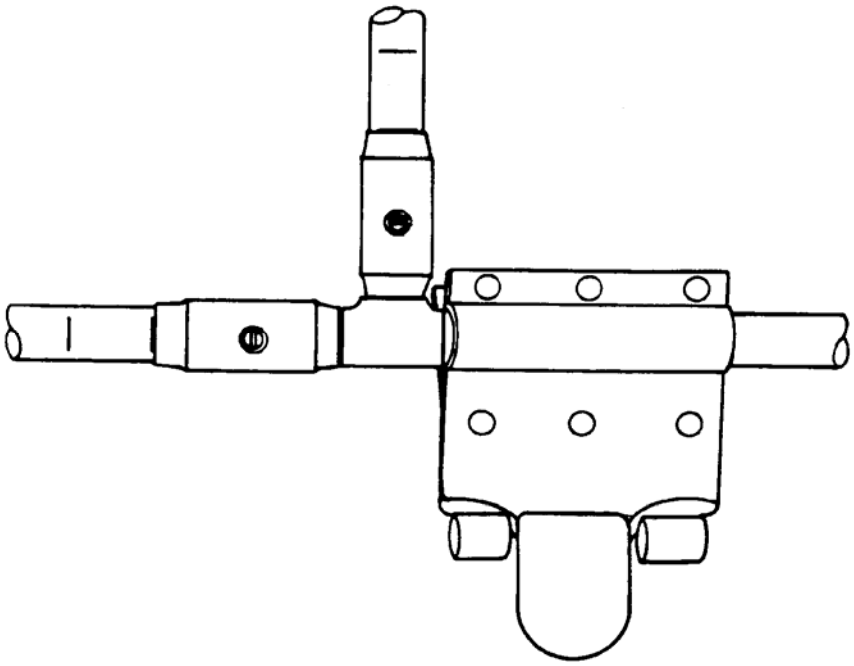
016011

Figure 11. Locating Insertion Marks on Tee Assembly



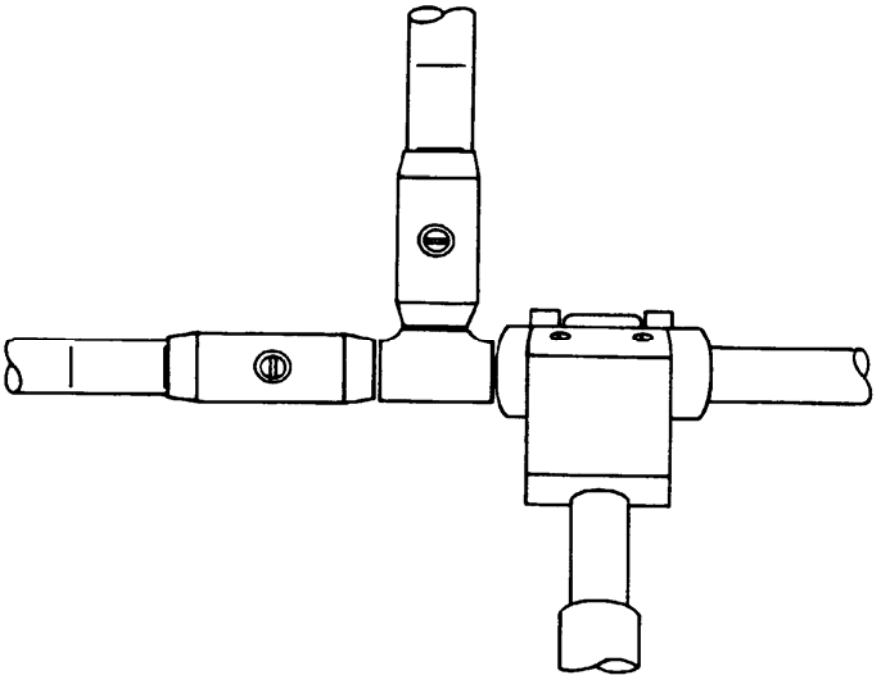
016012

Figure 12. Locating Check Gage Marks on Tee Assembly



016013

Figure 13. Application of Tube Chiller on Fitting Leg and Tube



016014

Figure 14. Installing Coupling

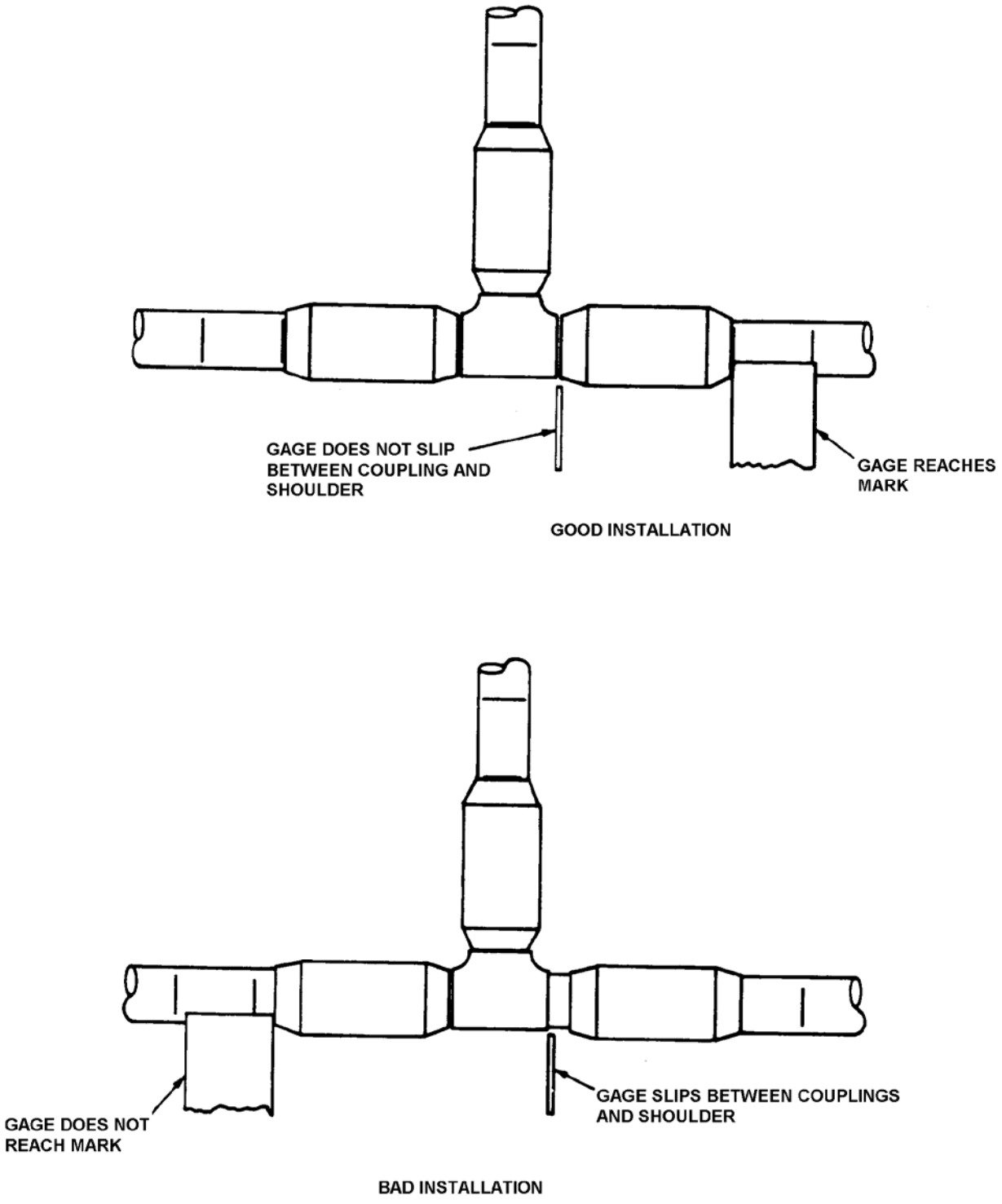


Figure 15. Checking Coupling

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION AND MAINTENANCE

RYNGLOK® FITTINGS

Reference Material

Permaswage Fittings, Description and Maintenance..... WP011 00

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Alternative Tube Marking	3
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Optional Air/Hydraulic Intensifier	3
Preswaging Procedures	2

Record of Applicable Technical Directives

None

1. GENERAL.

2. This section provides instructions for the repair of aircraft tubing utilizing Rynglok® fittings manufactured by Aeroquip Corp. The Rynglok® fittings, mechanically swaged onto the tubing, is considered a permanent repair method. The Rynglok® fitting system is applicable to every material and wall thickness of tubing used on all Naval aircraft with hydraulic operating systems up to 8,000 psi. Every equivalent configuration and style of permanent and separable fitting used on Naval aircraft is available with the Rynglok® system. The Rynglok® fitting is simple to install and may be used by maintenance personnel at all activity levels. The most commonly used configurations are shown in Table 1.

3. TUBE ASSEMBLY REPAIR WITH RYNGLOK® FITTINGS. Repairs performed with Rynglok® fittings and installation tool are considered permanent repairs. The maximum pressure ratings of Rynglok® fittings, summarized in Table 2, equal or exceed the pressure ratings of the tubing used on present-day aircraft and are intended to satisfy the repair requirements of future aircraft which will utilize ultra-high-pressure hydraulic systems. Rynglok® fittings may be used to repair any wall thickness of tubing for any of the commonly used tubing materials listed in Table 3.

Verify that new tubing material used for splice repairs equals or exceeds the pressure rating of the tubing being replaced.

4. Common Types of Tubing Repair or Duplications. With the availability of the numerous types of permanent and separable Rynglok® fittings presented in Table 1, it is possible to repair or duplicate almost any tube assembly. In addition to having the ability to duplicate or splice on to existing tube assemblies with the configurations described in Table 1, it is also possible to solve the majority of tubing repair problems with single-fitting repairs as described in Table 4. Table 5 lists cutoff lengths for repair of damaged, flareless lipseal and flared, separable end fittings.

5. RYNGLOK® EQUIPMENT. All of the Rynglok® tooling necessary to repair any aircraft is packaged in a single carrying case along with a hydraulic hand pump which powers all of the tools. A marking pen, tube marking tools, and inspection gages are also included. Because some repair activities do not require a full repair capability, several versions of the Rynglok® tool kit are available, as summarized in Table 6.

NOTE

The tool kits listed in Table 6 are to be used only for installing fittings with part numbers beginning with “R8” (8,000 psi).

6. PROCEDURES.

7. PRESWAGING PROCEDURES. To cut and debuff tubing in preparation for the swaging of Rynglok® repair fittings, the procedures and equipment described in WP011 00 should be utilized.

a. Tube end preparation and cleanliness criteria for Rynglok® are no greater than the standards for good practice associated with the other methods of tube joining described in this document.

8. INSTALLATION PROCEDURES. All Rynglok® tube fittings, regardless of their configuration, are installed in accordance with the 6-step procedure of Figure 1.

NOTE

The recommendation that the Rynglok® tool always be pressurized to 8,000 psi is part of a simplified operating instruction. There is no need to visually verify with the pressure gage that 8,000 psi has been reached, as swaging is almost always accomplished before reaching full pressure. The pump has a relief mechanism set to prevent pressurization beyond 8,000 psi.

a. In the event that the inspection gage indicates that the ring portion of the fitting has not been pushed fully into position, the Rynglok® tool should be reapplied and pressurized to 8,000 psi. The inspection gage should again be used to verify that the ring is fully advanced.

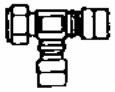
9. ALTERNATIVE TUBE MARKING. Accessory items such as the marking gages shown in the procedure of Figure 1 are sometimes misplaced. As an alternative method, the dimensions shown in Table 7 can be used to mark the tubing in the absence of a Rynglok® marking tool.

10. OPTIONAL AIR/HYDRAULIC INTENSIFIER. For using activities which have a compressed air source in the range of 60 psi to 150 psi available, two alternatives to the hydraulic hand pump are available.

11. 10-00401A Foot-Operated Intensifier. This unit, when connected to a 60 psi or greater compressed air source, will provide 8,000 psi hydraulic pressure to the Rynglok® tool when the operator depresses one side of a foot-operated petal. By depressing the other side of the foot pedal, the operator depressurizes the pump to 0 psi.

12. Remote-Control Intensifier. For those operators who prefer to use a hand-operated remote control switch to pressurize the Rynglok® swaging tool, a unit is also available. The hand-operated toggle switch provides 8,000 psi hydraulic pressure activation when pushed to one side and depressurizes the pump to 0 psi when pushed to the opposite side.

Table 1. Rynglok® Tube Fitting Configurations

		PERMANENT TO LIPSEAL		
	PERMANENT TO PERMANENT	MALE	MALE BULKHEAD	FEMALE ArcSeal
UNION				
Non-Reducer	R80101T( )	R81121T( )	R81141T( )	R81101T( )
Reducer	R80151T( )( )	R81171T( )( )	R81191T( )( )	R81151T( )( )
45° ELBOW				
Non-Reducer	R80102T( )	R81122T( )	R81142T( )	R81102T( )
Reducer	R80152T( )( )	R81172T( )( )	R81192T( )( )	R81152T( )( )
90° ELBOW				
Non-Reducer	R80103T( )	R81123T( )	R81143T( )	R81103T( )
Reducer	R80153T( )( )	R81173T( )( )	R81193T( )( )	R81153T( )( )
TEE (Separable on Run)				
Non-Reducer	R80104T( )	R81124T( )	R81144T( )	R81104T( )
Reducer	R80154T( )( )	R81174T( )( )( )	R81194T( )( )( )	R81154T( )( )( )
TEE (Separable on Side)				
Non-Reducer		R81126T( )	R81146T( )	R81106T( )
Reducer		R81176T( )( )( )	R81196T( )( )( )	R81156T( )( )( )

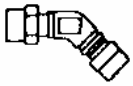
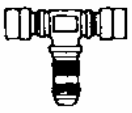
017t01a

Table 1. Rynglok® Tube Fitting Configurations (Cont)

	PERMANENT TO "MS" FLARELESS		
	MS33514	MS33515	NAS 1760 MODIFIED
UNION			
Non-Reducer	R82121T( )	R82141T( )	R82101T( )
Reducer	R82171T( )( )	R82191T( )( )	R82151T( )( )
45° ELBOW			
Non-Reducer	R82122T( )	R82142T( )	R82102T( )
Reducer	R82172T( )( )	R82192T( )( )	R82152T( )( )
90° ELBOW			
Non-Reducer	R82123T( )	R82143T( )	R82103T( )
Reducer	R82173T( )( )	R82193T( )( )	R82153T( )( )
TEE (Separable on Run)			
Non-Reducer	R82124T( )	R82144T( )	R82104T( )
Reducer	R82174T( )( )( )	R82194T( )( )( )	R82154T( )( )( )
TEE (Separable on Side)			
Non-Reducer	R82126T( )	R82146T( )	R82106T( )
Reducer	R82176T( )( )( )	R82196T( )( )( )	R82156T( )( )( )

017t01b

Table 1. Rynglok® Tube Fitting Configurations (Cont)

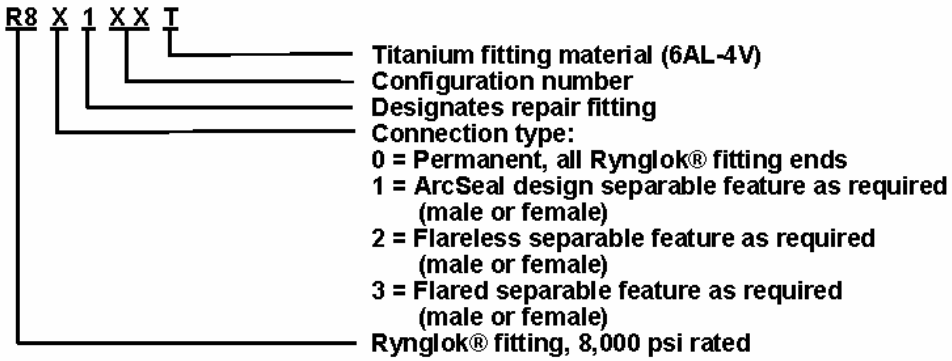
	PERMANENT TO "AN" FLARED		
	MS33656	MS33657	AS1708
UNION			
Non-Reducer	R83121T( )	R83141T( )	R83101T( )
Reducer	R83171T( )( )	R83191T( )( )	R83151T( )( )
45° ELBOW			
Non-Reducer	R83122T( )	R83142T( )	R83102T( )
Reducer	R83172T( )( )	R83192T( )( )	R83152T( )( )
90° ELBOW			
Non-Reducer	R83123T( )	R83143T( )	R83103T( )
Reducer	R83173T( )( )	R83193T( )( )	R83153T( )( )
TEE (Separable on Run)			
Non-Reducer	R83124T( )	R83144T( )	R83104T( )
Reducer	R83174T( )( )	R83194T( )( )( )	R83154T( )( )( )
TEE (Separable on Side)			
Non-Reducer	R83126T( )	R83146T( )	R83106T( )
Reducer	R83176T( )( )( )	R83196T( )( )( )	R83156T( )( )( )

017t01c

Table 1. Rynglok® Tube Fitting Configurations (Cont)

RYNGLOK® FITTING PART NUMBER SYSTEM AND HOW TO ORDER INFORMATION

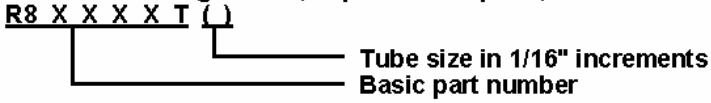
BASIC PART NUMBER DESIGNATION



Example: R81103T
Rynglok® fitting, 8,000 psi rated, female ArcSeal design separable to Rynglok® fitting in the 90° elbow configuration.

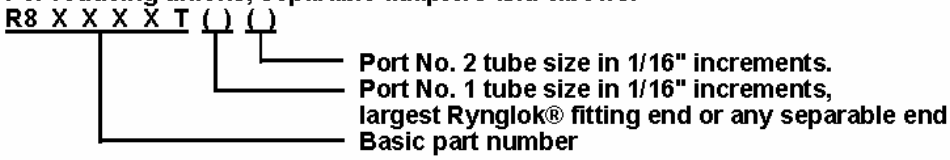
HOW TO ORDER

For non-reducing unions, separable adapters, elbows and tees:



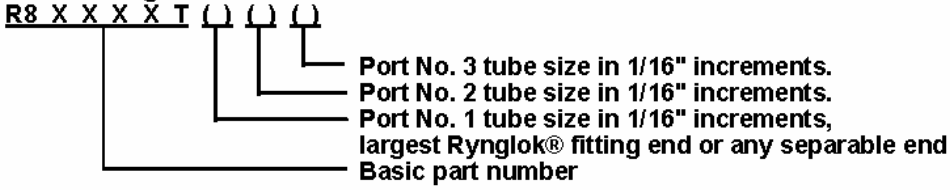
Example: R81102T06
Rynglok® fitting, 8,000 psi rated, 45° elbow, female ArcSeal design to Rynglok® fitting for 3/8" tube size.

For reducing unions, separable adapters and elbows:



Examples: R81153T0608
Rynglok® fitting, 8,000 psi rated, 90° elbow reducer, 3/8" tube size female ArcSeal design to 1/2" tube size Rynglok® fitting.

For reducing tees:



Example: R80154T100806
Rynglok® fitting, 8,000 psi rated, reducing tee, all legs permanent. Port No. 1 – 3/8" tube size, Port No. 2 – 1/2" tube size, Port No. 3 – (side leg) 3/4" tube size.

Example: R81154T08604
Rynglok® fitting, 8,000 psi rated, reducing tee with female ArcSeal design separable. Port No. 1 – 1/2" tube size, Port No. 2 – 3/8" tube size, Port No. 3 – 1/4" tube size.

NOTE: Port numbering system is in accord with AIR 1590.

For additional information, dimensional and weight data, contact Aeroquip Corporation, Aerospace Division, Jackson, Michigan.

017t01d

Table 2. Rynglok® Fitting Maximum Pressure Rating

Tube O.D. (Inch)	Maximum Pressure Rating
3/16	8,000 psi
1/4	8,000 psi
5/16	8,000 psi
3/8	8,000 psi
1/2	8,000 psi
5/8	8,000 psi
3/4	8,000 psi
7/8	4,000 psi
1.0	5,000 psi
1 1/4	4,000 psi
1 1/2	2,500 psi

Table 3. Tubing Materials Compatible with Rynglok® Fittings

Corrosion Resistant Steel	Titanium	Aluminum
21-6-9	3AL-2.5V CWSR	6061-T6
AM350	3AL-2.5V Annealed	5052-0
304 1/8H		
304L 1/8H		
304 Annealed		
321 1/8H		
321 Annealed		
347 Annealed		

Table 4. Tube Assembly Failures and Recommended Repair Methods

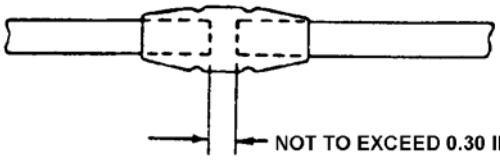
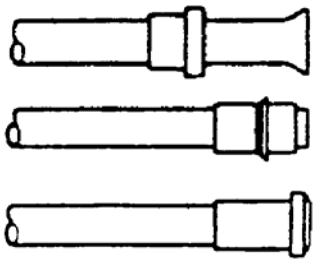
Type of Failure	Repair Method
1. Pinhole Leak or Circumferential Crack in Tubing.  017t04a	1. a. Make 1 or 2 cuts as necessary, to remove damaged section. If 2 cuts are required, the distance between them shall not exceed 0.30 inch. If distance is more than 0.30 inch, use two unions and a splice section of tubing. b. Swage 1 tube to tube union in tube section under repair.
2. Leaking Flared, Flareless or Lipseal End Fittings.  017t04b	2. a. Cut tubing to remove defective fitting. b. Swage appropriate end fitting to tube end. c. Connect new end fitting to mating connection, torquing nut as required. **NOTE** The replacement Rynglok® fitting can be attached to the tubing after tightening the nut, thereby assuring a properly-aligned stress-free installation.

Table 5. Cutoff Lengths for Repair of Damaged, Flareless Lipseal and Flared Separable End Fittings

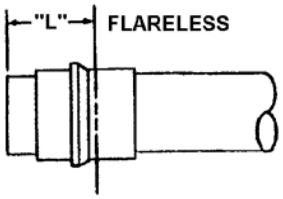
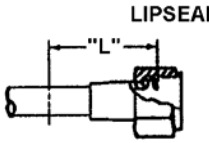
	Damaged/Discarded/Fitting			Flareless	Repair/Replacement Fitting	"L"
	Size	Flareless Sleeve Part Number	Flareless Nut Part Number	Description	Rynglok® Part Number	Cutoff Length + or - 0.03
 017t05a	-3	AS21922-3	AS21921-03	"MS" Sleeve and Nut Assembly	R82101T03	0.602
	-4	AS21922-4	AS21921-04	"MS" Sleeve and Nut Assembly	R82101T04	0.616
	-5	AS21922-5	AS21921-05	"MS" Sleeve and Nut Assembly	R82101T05	0.695
	-6	AS21922-6	AS21921-06	"MS" Sleeve and Nut Assembly	R82101T06	0.726
	-8	AS21922-8	AS21921-08	"MS" Sleeve and Nut Assembly	R82101T08	0.837
	-10	AS21922-10	AS21921-10	"MS" Sleeve and Nut Assembly	R82101T10	0.979
	-12	AS21922-12	AS21921-12	"MS" Sleeve and Nut Assembly	R82101T12	1.004
	-14	AS21922-14	AS21921-14	"MS" Sleeve and Nut Assembly	R82101T14	1.066
	-16	AS21922-16	AS21921-16	"MS" Sleeve and Nut Assembly	R82101T16	1.135
	-20	AS21922-20	AS21921-20	"MS" Sleeve and Nut Assembly	R82101T20	1.165
	-24	AS21922-24	AS21921-24	"MS" Sleeve and Nut Assembly	R82101T24	1.395
NOTE: The above illustration shows a standard AS21922 sleeve, but the same cutoff dimension applies to flareless sleeves/ends which are internally swaged or weld-attached.						
	Damaged/Discarded/Fitting			Lipseal	Repair/Replacement Fitting	"L"
	Size	Aeroquip Dynatube® Part Number	Resistoflex Dynatube® Part Number	Description	Rynglok® Part Number	Cutoff Length + or - 0.03
 R4427TPT MR54040 OR MR44000P 017t05b	-3	AE16170-3	MR54040T-03	Swivel Adapter	R81101T03	0.463
	-4	AE16170-4	MR54040T-04	Swivel Adapter	R81101T04	0.496
	-5	AE16170-5	MR54040T-05	Swivel Adapter	R81101T05	0.513
	-6	AE16170-6	MR54040T-06	Swivel Adapter	R81101T06	0.528
	-8	AE16170-8	MR54040T-08	Swivel Adapter	R81101T08	0.596
	-10	AE16170-10	MR54040T-10	Swivel Adapter	R81101T10	0.682
	-12	AE16170-12	MR54040T-12	Swivel Adapter	R81101T12	0.754
	-14	AE16170-14	MR54040T-14	Swivel Adapter	R81101T14	0.819
	-16	AE16170-16	MR54040T-16	Superseded by AE16451-16	R81101T16	0.837
	-20	AE16170-20	MR54040T-2120	Swivel Adapter	R81101T20	0.883
	-24	AE16170-24	MR54040T-2524	Swivel Adapter	R81101T24	1.023
		AE16451-16	MR54040T-16	Swivel Adapter	R81101T16	1.030
NOTE: The above cutoff dimension applies to both internally swaged or weld-attached Lipseal fittings.						

Table 5. Cutoff Lengths for Repair of Damaged, Flareless Lipseal and Flared Separable End Fittings (Cont)

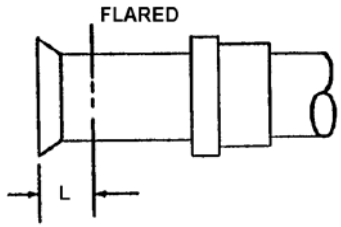
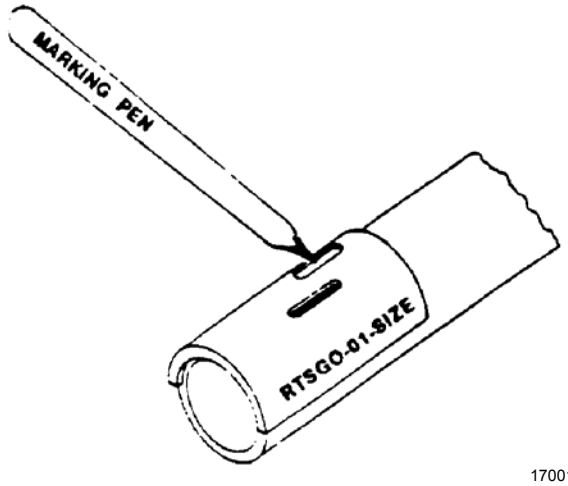
	Damaged/Discarded/Fitting			Flared	Repair/Replacement Fitting	"L"
	Size	Flared Sleeve Part Number	Flared Nut Part Number	Description	Rynglok® Part Number	Cutoff Length + or - 0.03
	-3	AS5176-3	AN818-03	Flared Sleeve and Nut Assembly	R83101T03	0.662
	-4	AS5176-4	AN818-04	Flared Sleeve and Nut Assembly	R83101T04	0.701
	-5	AS5176-5	AN818-05	Flared Sleeve and Nut Assembly	R83101T05	0.748
	-6	AS5176-6	AN818-06	Flared Sleeve and Nut Assembly	R83101T06	0.779
	-8	AS5176-8	AN818-08	Flared Sleeve and Nut Assembly	R83101T08	0.920
	-10	AS5176-10	AN818-10	Flared Sleeve and Nut Assembly	R83101T10	1.045
	-12	AS5176-12	AN818-12	Flared Sleeve and Nut Assembly	R83101T12	1.085
	-16	AS5176-16	AN818-16	Flared Sleeve and Nut Assembly	R83101T16	1.214
	-20	AS5176-20	AN818-20	Flared Sleeve and Nut Assembly	R83101T20	1.298
	-24	AS5176-24	AN818-24	Flared Sleeve and Nut Assembly	R83101T24	1.477

Table 6. Rynglok® Tool Kits for Various Tubing Sizes

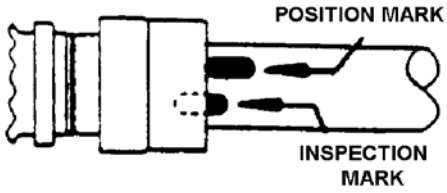
Kit Part Number	Tubing Sizes										
RTSK8-02-001	-03,	-04,	-05,	-06,	-08,	-10,	-12,	-14,	-16,	-20,	-24
RTSK8-02-004	-04,	-06,	-08,	-10,	-12,	-14,	-16,	-20,	-24		
RTSK8-02-002	-06,	-08,	-10,	-12,	-14,	-16,	-20,	-24,			
RTSK8-02-005	-04,	-06,	-08,	-10,	-12,	-16,	-20,	-24			
RTSK8-02-006	-04,	-06,	-08,	-10,	-12,	-16,	-20				
RTSK8-02-008	-04,	-06,	-08,	-10,	-12,	-16					
RTSK8-02-009	-04,	-06,	-08,	-10,	-12						
RTSK8-02-010	-04,	-06,	-08,	-10							
RTSK8-02-011	-04,	-06,	-08								
RTSK8-02-021	-16,	-20,	-24								
RTSK8-02-029	-03,	-05									
RTSK8-02-030	-10,	-12									



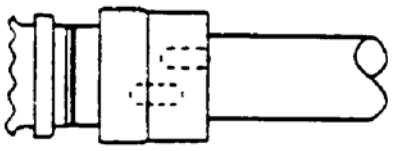
1700101a

STEP 1

Select the proper RTSGO-01-size marking gage. Position the gage on the end of the cut tube. Use a suitable marking pen to make the positioning marks. Remove gage.



FITTING POSITION FOR MINIMUM TUBE INSERTION

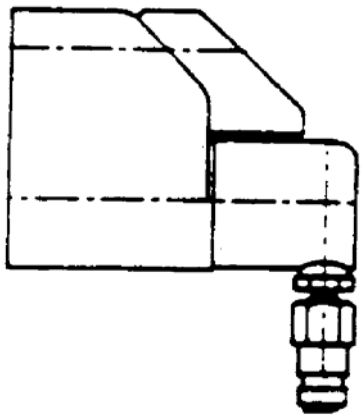


FITTING POSITION FOR MAXIMUM TUBE INSERTION

1700101b

STEP 2

Install fitting on tube and use the positioning mark to position the edge of the unswaged fitting ring over the mark. (See figures) The edge of the fitting ring may be anywhere along the length of the positioning mark.

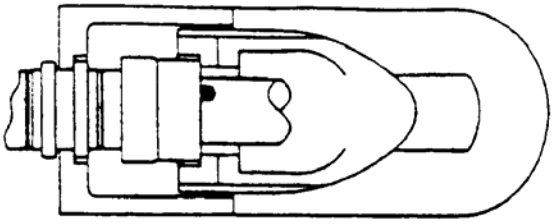


1700101c

STEP 3

Select the correct size assembly tool. Attach the flexible hose with the mating quick disconnect coupler to the nipple at the bottom of the tool, and the nipple end of the hose to the mating quick disconnect coupler on the pump.

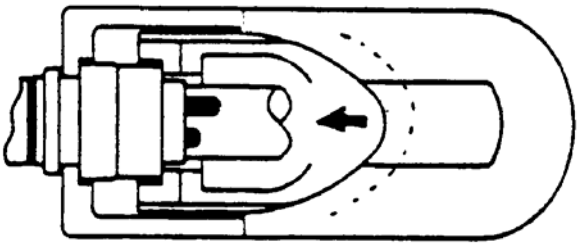
Figure 1. Rynglok® Tube Fitting, Installation Sequence (Sheet 1 of 2)



TOOL POSITION BEFORE PRESSURIZATION
1700102a

STEP 4

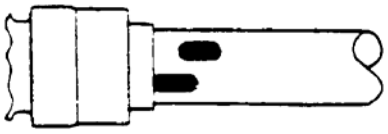
Position the tool onto the fitting, with the ring nested into the movable jaw of the tool and the front opening of the tool bottomed into the fitting. Make sure that the fitting is bottomed into the tool.



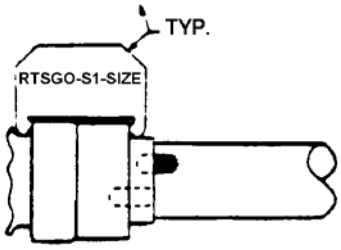
TOOL POSITION DURING PRESSURIZATION
1700102b

STEP 5

Pressurize the tool to advance the fitting ring. Apply 8,000-8,500 psig hydraulic pressure. Release pressure. The movable jaw of the assembly tool will return to the original position.



INSPECTION MARK AT MINIMUM TUBE INSERTION



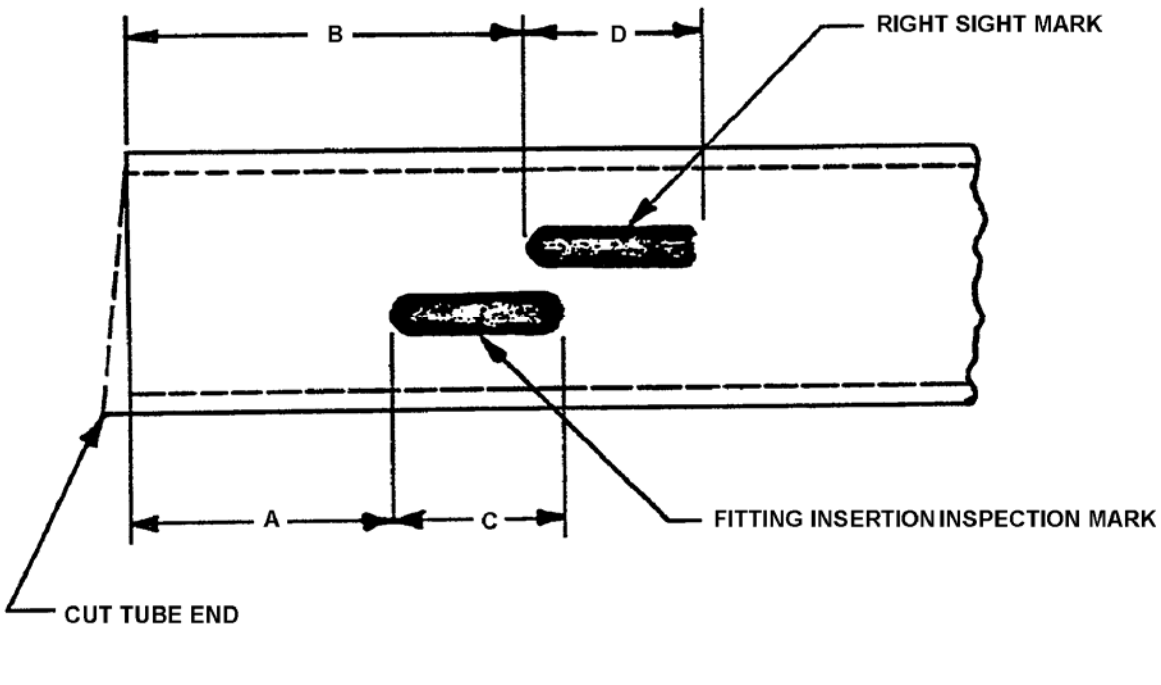
INSPECTION MARK AT MAXIMUM TUBE INSERTION
1700102c

STEP 6

The fitting installation should be verified by visual inspection that the ring is fully advanced on to the fitting using the inspection gage RTSGO-51-size, which should fit over the ring after swaging. Also verify that the edge of the fitting is touching or over the insertion mark.

Figure 1. Rynglok® Tube Fitting, Installation Sequence (Sheet 2)

Table 7. Alternative Tube Marking for Rynglok® Fittings



Dash Size	Tube O.D.	A ± .005	B ± .005	C ± .005	D ± .005
-03	0.1875	0.453	0.634	0.300	0.300
-04	0.2500	0.525	0.707	0.300	0.300
-05	0.3125	0.588	0.770	0.300	0.300
-06	0.3750	0.656	0.833	0.300	0.300
-08	0.5000	0.773	0.953	0.350	0.350
-10	0.6250	0.899	1.078	0.350	0.350
-12	0.7500	1.042	1.222	0.350	0.350
-14	0.8750	1.178	1.359	0.350	0.350
-16	1.0000	1.299	1.488	0.400	0.400
-20	1.2500	1.572	1.771	0.400	0.400
-24	1.5000	1.862	2.076	0.400	0.400

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ORGANIZATIONAL, INTERMEDIATE AND DEPOT MAINTENANCE

DESCRIPTION AND MAINTENANCE

HIGH VOLUME AIR DELIVERY DUCT ASSEMBLIES

AIR FORCE USE ONLY

Reference Material

Duct and Scuff Cover, Pneumatic, Flexible MIL-DTL-22706

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Record of Applicable Technical Directives

None

1. GENERAL.

2. This section is for Air Force Use only.

3. This section establishes inspection criteria, installation procedures, field assembly and repair details for high volume air delivery duct assemblies, Part No. MIL-DTL-22706 and Part No. 51155-15-14-60. The duct assemblies are installed on high volume air compressors that are used for starting aircraft jet propulsion engines.

4. INSPECTION - MONTHLY/PERIODIC.

5. Concentrate inspection immediately behind coupling assemblies to detect material fatigue.

6. Inspect outer surfaces of the duct material and scuff cover for punctures, cut or torn fabric.

7. Inspect coupler assemblies for distortions, out-of-round conditions, flat spots resulting from dragging and cracks. After visual inspection of couplers, tap lightly with a hammer. If ringing sound is not heard, inspect and ensure that the guide pins are not touching the inner portion of the coupler (reference Figure 7). If the pins are touching the inner portion, gently pry pins away and ring test again. If ringing sound is heard, the coupler is good. Torque coupler half retaining screws or clamps.

8. INSTALLATION.

9. Prior to attempting hook-up between unit and aircraft, lay the duct assembly on a hard, clean surface, stretched out to full length in a straight line.

10. Align the servicing unit to approximately 45° angle of the aircraft and locate at a distance that will utilize the fully stretched out length of the duct assembly for hook-up in uniform long sweeping bends.

11. Secure servicing unit by chocking wheels or applying hand brake.

12. Connect duct assembly to servicing unit if required.

a. Initiate servicing starting procedures and apply pneumatic load for a minimum of 10 seconds to ensure duct is free of debris or obstructions.

b. Shut off servicing unit.

WARNING

The free end of the pneumatic hose shall be suitably restrained by tying to a fixed fixture or weighted with fifty or more pounds of weight before initiating pneumatic loading.

13. Complete hook-up to aircraft and inspect couplings for complete engagement, observing after hookup that alignment of the assembly contains no short bends, kinks or twists.

14. Initiate starting operations.

15. ASSEMBLY.

16. **Duct Assembly Utilizing Fitting, Part No. MS17833 or MS17835**, reference Figure 1 and 2.

WARNING

Do not use any form of lubricant to facilitate hose assembly.

a. Insert duct (1) over fitting (4) until flush with stop pins.

b. Install clamps, Part No. 420-75-388SH in first and second positions on fitting. Stagger clamps 120 degrees axially. Torque clamps to 50 inch pounds over running torque, not to exceed 70 inch pounds. Alternate clamps Part No. HTM400L may be used if necessary.

NOTE

Cutting off the protruding end of "T" bolts is optional, providing ends are deburred and extend 2 full threads through the nut.

c. Install scuff cover (2) over duct (1) approximately 1/4 inch from second clamp. Install third clamp, Part No. QS200M56S over scuff cover. Stagger 120 degrees axially from second clamp. Torque 30-35 inch pounds. A larger clamp Part No. QS200M64S may be required due to some differences in hose thickness.

NOTE

The third clamp shall be installed in this position even if the fitting is marked - do not clamp here.

d. Proof test hose assembly before hooking it up to an aircraft by connecting it to an air conditioner (AM32C10) or locally manufactured dummy load capable of simulating load conditions, and perform an operational check using normal output pressure of servicing compressor unit to insure security of the hose assembly. Re-torque clamps Part No. 420-75-388SH and clamps Part No. QS200M56S.

17. **Duct Assembly Utilizing Fitting, Part No. 9130**, reference Figures 3 and 4.

a. Inspect duct (1) over fitting (5) until flush with raised lip.

b. Install scuff cover (2) over duct (1).

NOTE

End of scuff cover will be approximately one inch from end of duct and retaining lip. This will allow approximately three inches of the scuff cover to be under the coupling when clamped.

c. Install coupling halves (4), on fitting (5), mating slot in halves with retaining lip on fitting.

d. Install screws (3) and torque to 40 inch-pounds.

18. **Duct Assembly Utilizing Fitting, Part No. FT2423**, reference Figures 5 and 6.

a. Insert duct (1) over fitting (5) until flush with forward shoulder.

b. Install scuff cover (2) over duct (1).

NOTE

End of scuff cover will be approximately one inch from end of duct and forward shoulder. This will allow approximately three inches of the scuff cover to be under the coupling when clamped.

c. Install coupling halves (4), on fitting (5), with small end of taper forward and flush with forward shoulder of fitting.

d. Install screws (3) and torque to 55 inch-pounds.

19. MINOR REPAIRS.

20. Depreciation of inner tube material adjacent to coupling.

a. Remove coupling and fitting from duct assembly and cut off three inches of extreme end.

b. Inspect new mounting area by flexing material, and if depreciation still exists, cut off an additional three inches and inspect.

c. If material depreciation exists after fourth cut-off, replace inner duct.

NOTE

Minimum allowable length after repairs is 25/55 feet as applicable. Outer scuff cover material will not be cut off accordingly.

d. Install coupling and fitting in accordance with paragraph 15.

e. Perform proof test and re-torque clamps in accordance with paragraph 15d.

21. Separation of spiral rubber scuff guard from nylon mesh cover.

a. Protruding ends of the scuff guard resulting from failure of adhesion will be repaired by stitching the scuff guard to the nylon mesh, three or more circular stitches spaced two inches apart will be installed starting from the loose end. Independently “tied off” stitches will be used.

b. Repairs can be accomplished with a curved upholstery needle (NSC8315) and nylon twine (NSC4020).

22. Rupture or tear in duct can be repaired as follows:

a. Make a square cut across duct on each side of rupture or tear.

b. Insert hose connector, Part No. 6489-56.

c. Secure with 4 clamps, Part No. 420-75-388SH two on each side of the splice. Stagger clamps 120 degrees axially.

d. Torque clamps to 60 inch-pounds.

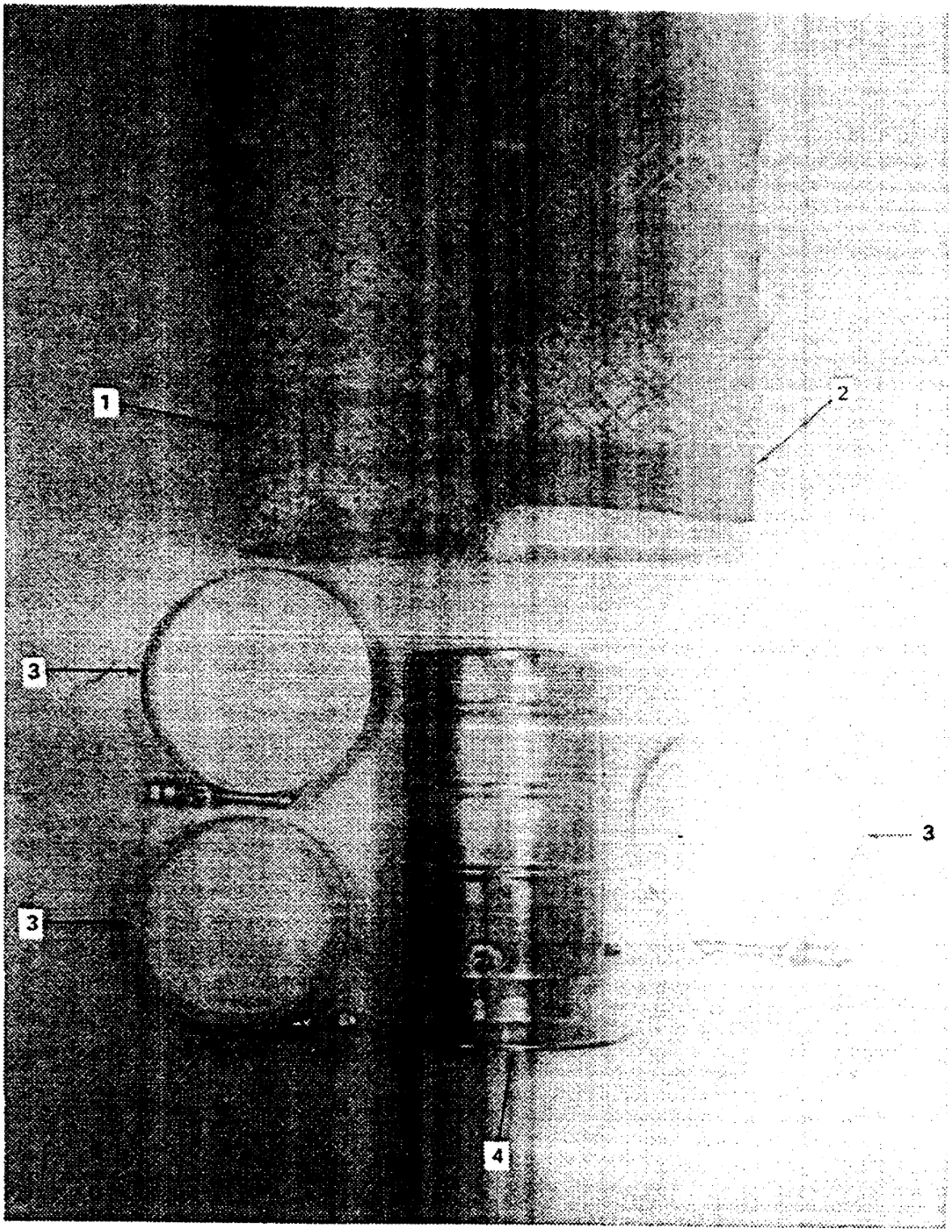

Figure 1: Duct Assembly

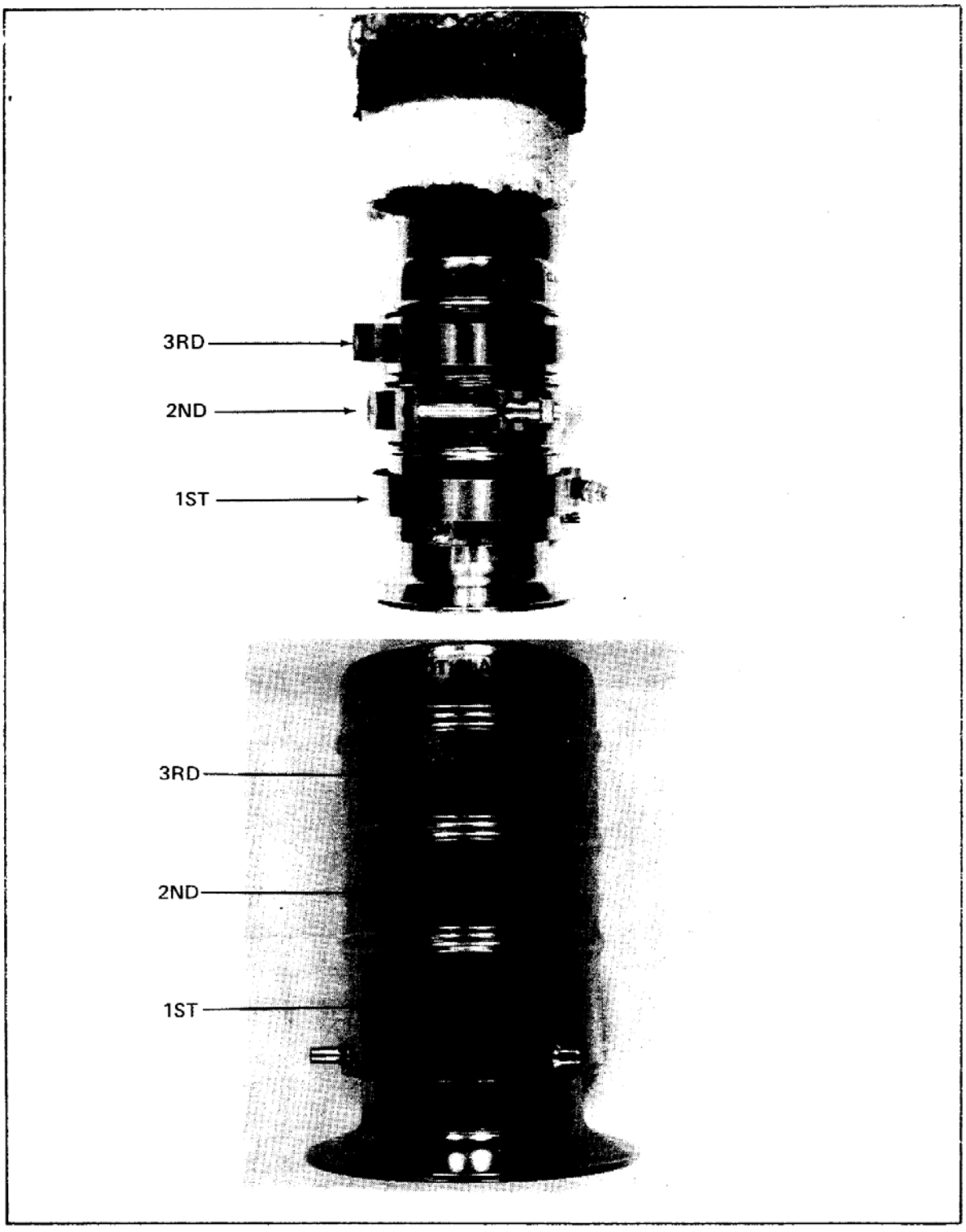

Figure 2: Clamp Positions

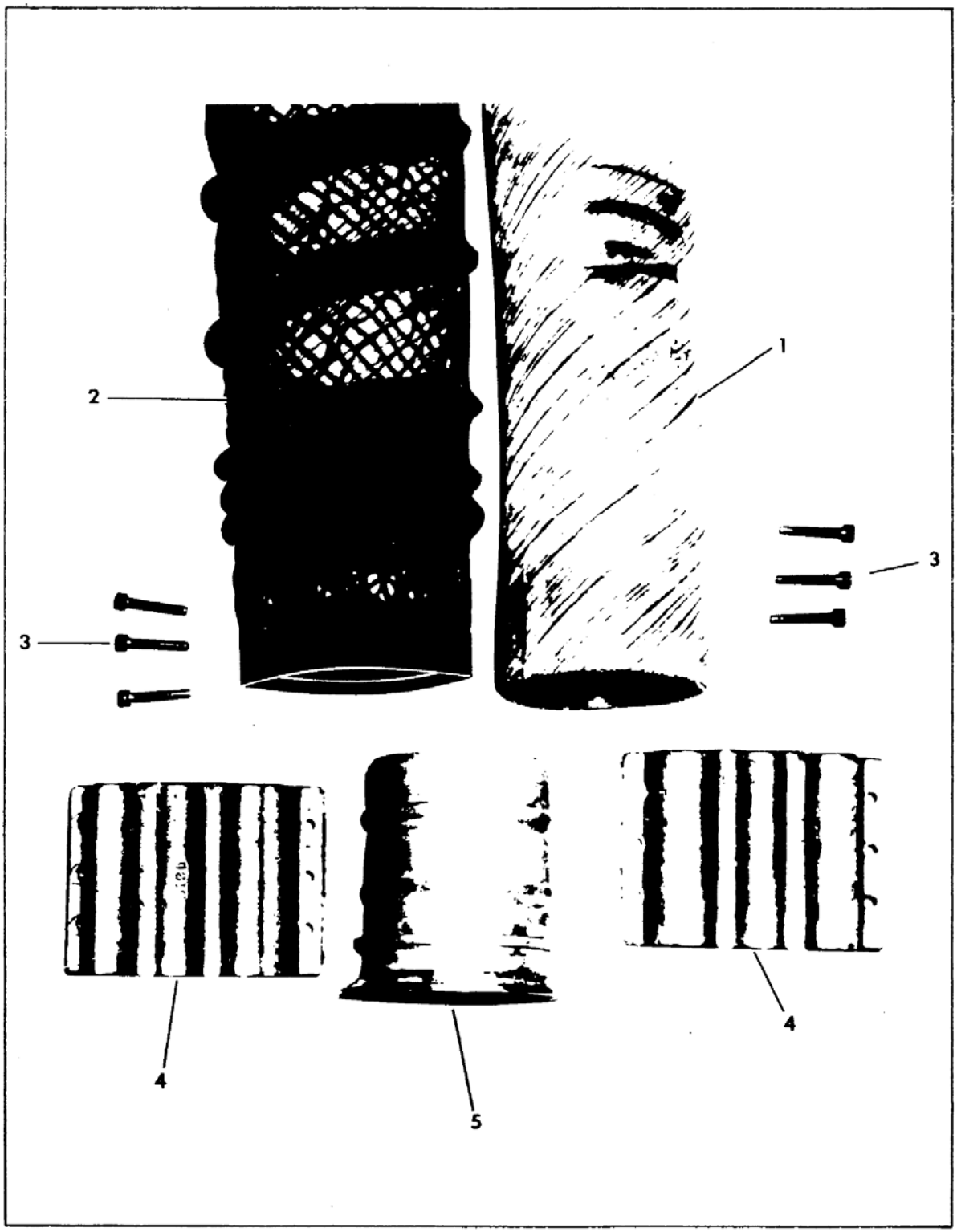

Figure 3: Duct Assembly

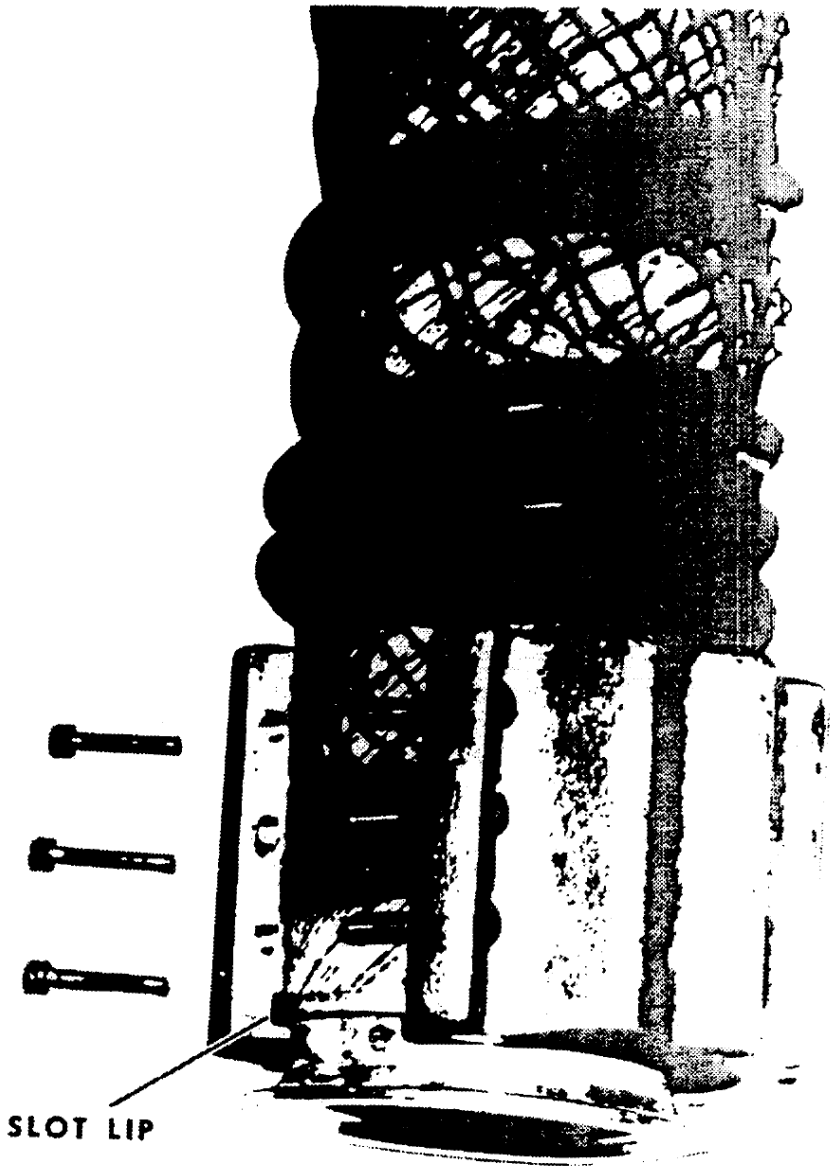

Figure 4: Duct Assembly

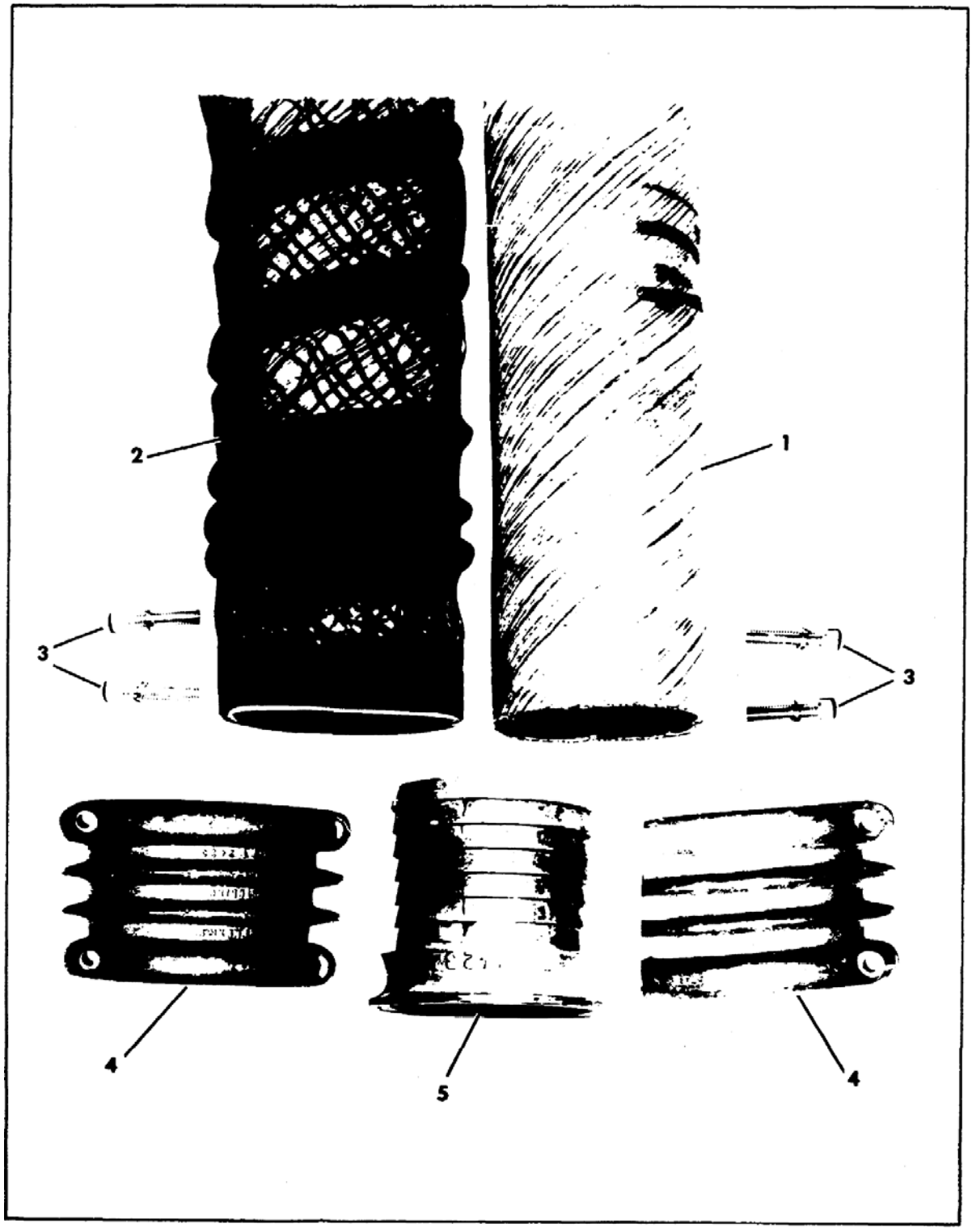

Figure 5: Duct Assembly

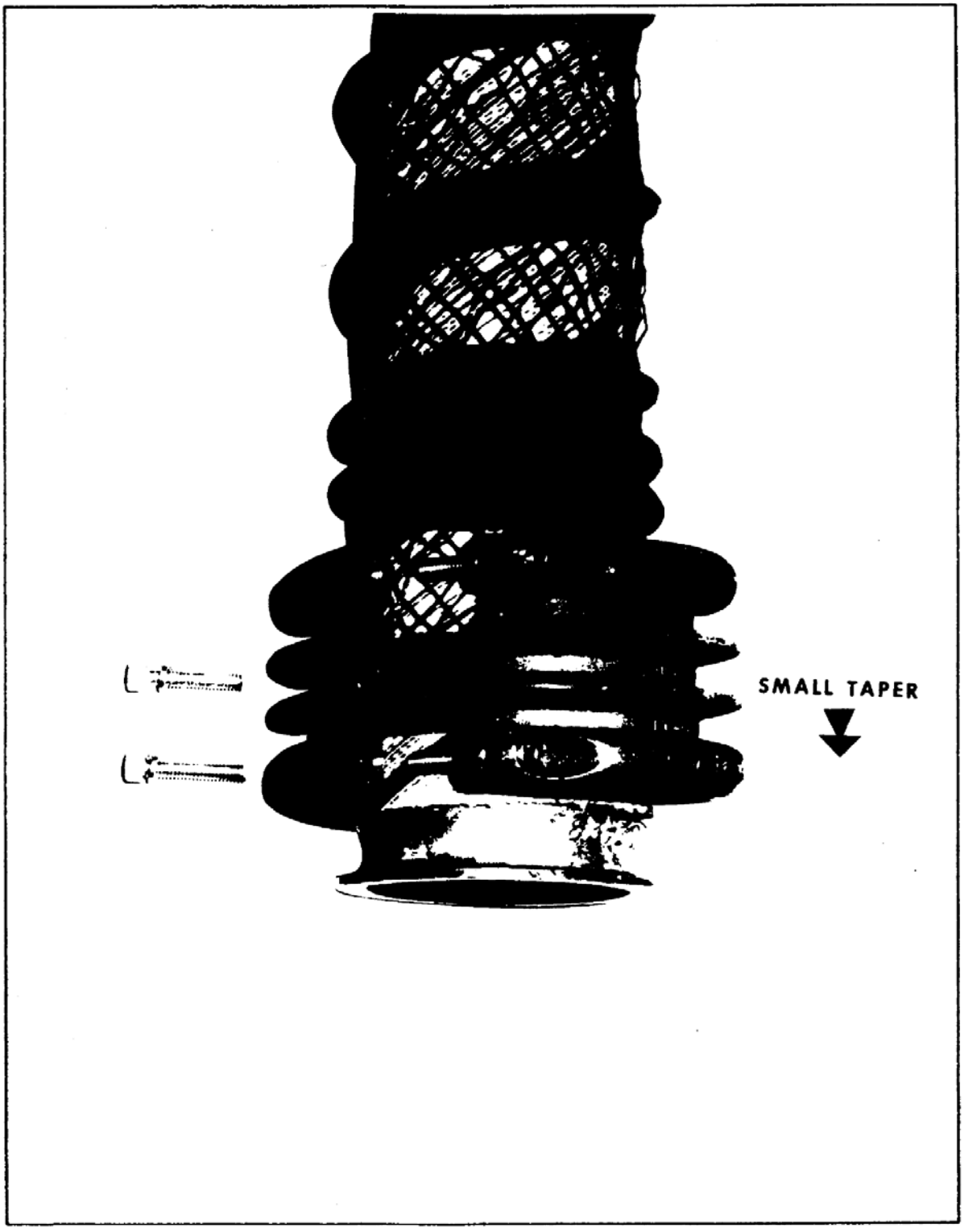

Figure 6: Duct Assembly

Table 1: Component Parts for Duct Assembly MIL-D-26124, 5OO°F, 30 Feet, NSN 4720-00-616-4645

NOMENCLATURE	PART NO.	NSN
Duct	10H09-30 (Replaces P/N 5184-30)	4720-01-435-0282 (Replaces 4720-00-564-1413)
Duct Cover, Alum	1061(21868)	
Asbestos Tubing		
Insulation		
Scuff Cover	M22706-S-30	4720-00-106-7360
Male Fitting	MS17833	4730-00-960-4569
Female Fitting	MS17835	4730-00-960-4568
*Hose Clamps (2)	QS200-M56S	4730-00-277-7132
**Hose Clamps	QS200-M64S	4730-00-274-5828
*Hose Clamps (4)	420-75-388SH	4730-00-032-2170
Alternate Clamps	HTM400L	4730-00-578-3355
Splice Connector	6489-56	4730-00-993-9261

COMPONENT PARTS FOR DUCT ASSEMBLY

P/N 51155-15-14-60, 600°F, 60 Feet, NSN 4720-00-820-6758

NOMENCLATURE	PART NO.	NSN
Duct	51154-60	4720-00-803-8359
Duct Cover, Alum	1061 (21868)	
Asbestos Tubing		
Insulation		
Scuff Cover	50859-60	2835-00-803-8362
Male Fitting	MS17833	4730-00-960-4569
Female Fitting	MS17833	4730-00-960-4568
*Hose Clamps (2)	QS200M56S	4730-00-277-7132
**Hose Clamps	QS200-M64S	4730-00-274-5828
*Hose Clamps (4)	420-75-388SH	4730-00-032-2170
Alternate Clamps	HTM400L	4730-00-578-8355

*Indicates subtraction, addition, quantities, part numbers, and national stock numbers of clamps.

**Use if larger clamp is necessary.

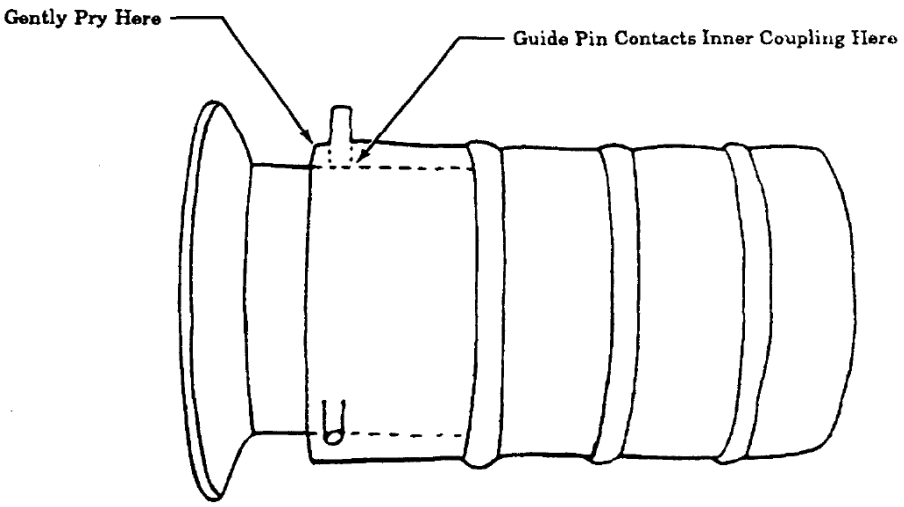

Figure 7: Coupling (Part Number MS17833 and MS 17835)